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THE TREATMENT OF WAR FRACTURES OF THE FEMUR

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TWO years of the present war have sufficiently proved the merits, disadvantages, and practicability of various methods of the treatment of compound war fractures of the extremities. The conclusion is clear and definite and may be formulated as follows:

It can be stated that a well performed operation followed by intensive local and general sulfonamide therapy and concluded by a closed plaster-of-Paris cast is, without any doubt, the best existing method for the treatment of compound war fractures including those of the femur. It is true for fresh wounds as well as for later cases. Even in the presence of a well developed infection, the same three principles remain the method of choice.

FRESH WOUNDS AND FRACTURES

There may arise two main objections to the principles stated for the treatment of fresh wounds and fractures. First, because of the great number of wounded to be dealt with during big battles, it is not possible to perform an extended careful wound excision upon every patient with a fracture of the femur because such a procedure requires too much time. Second, after imperfectly performed operations it is risky to apply a plaster-of-Paris cast for fear of gas gangrene, so it is preferable to wait for some days until this danger is over and meanwhile keep the patient in a transport splint.

To answer both objections, it must be emphasized that simple incisions and tamponade with gauze, containing any kind of antiseptics or vaseline, cannot replace the necessary excision of all damaged and contused tissues, and the removal of foreign bodies. Simple incisions are not a surgical aid but are only a primitive temporary measure. Patients thus treated should be regarded as having undergone no surgical treatment at all. This conclusion is all the more just because such wounded remain or are evacuated in transport splints; that is, without satisfactory immobilization. Unfinished operations, poor immobilization, and inevitable subsequent dressings—all these may lead to conditions suitable for the development of infections, particularly of gas gangrene. An absurd situation arises; one is fearful of gas gangrene, and therefore avoids putting on a closed cast at once, and thus creates conditions favorable for the development of infection.

It is necessary that all wounded with fractures of the femur be transported as early as possible to special field hospitals where qualified and final aid can be offered to a great number of wounded by means of the "conveyor" method.

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The operative principles are as follows: (1) wide excision of all injured and contused tissues regardless of the presence and degree of infection; (2) no drains of any kind are used; (3) continuous free drainage of the wound by means of a large counter-opening; (4) suture of the edges of the skin with catgut to the deep fascia, thus turning the wound inside out by the elastic traction of the skin; (5) during all the stages of the operation rich abundant washing of all parts of the wound with a soap solution; (6) after the excision and washing of all wound surfaces and bone ends, the application to these areas of a mixture of sulfanilamide and sulfathiazole in the proportion of three to one; finally, the application of a closed non-padded plaster-of-Paris cast.

In order to perform these steps as quickly as possible and with convenience, it is necessary to have an orthopedic table or some portable apparatus to obtain extension by means of screws. The table proposed for use (Figs. 1, 2, 3, 4) allows not only great extension and reposition of bone and an easy way for applying the plaster cast in case of any necessary flexion and abduction, but, what is most important, the operation itself is more easily performed by taking advantage of the lateral tilting of the table. This secures the best access to the lateral and even posterior surfaces of the thigh and makes the task easy whatever the level of the wound and fracture (Figs. 5–18).

The typical lateral approach, irrespective of the direction of the bullet or splinter, and the

Fig. 1.

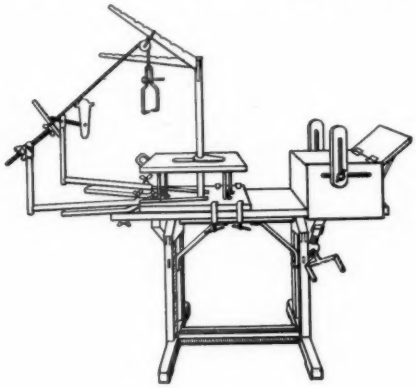


Fig. 2.

Fig. 3.

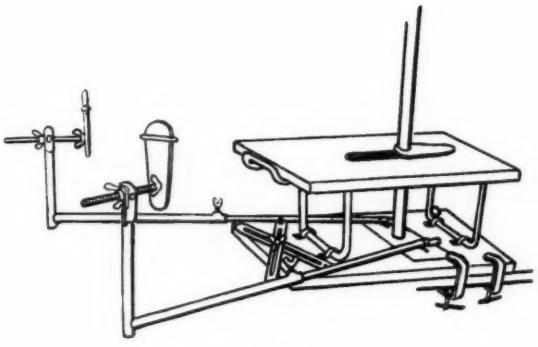


Fig. 4.

Figs. 1, 2, 3, and 4 are different views of the table used in our fracture work.

obligatory suturing of the skin edges to the deep fascia to insure continuous gaping of the entire wound simplify and standardize the operation. A portable x-ray apparatus is very desirable, but one may operate and secure bone reposition even without films. However, it is absolutely necessary to have a sufficient number of orthopedic tables or some kind of apparatus to obtain extension. Then, one skilled surgeon with a sufficient number of attendants will be able to treat successfully a large stream of wounded.

The conveyor method used by a "thigh brigade" working simultaneously on three tables (Fig. 19, 20, 21) may be described as follows. At the first table, after spinal anesthesia, three trained medical orderlies apply extension and carefully wash the wounded. This

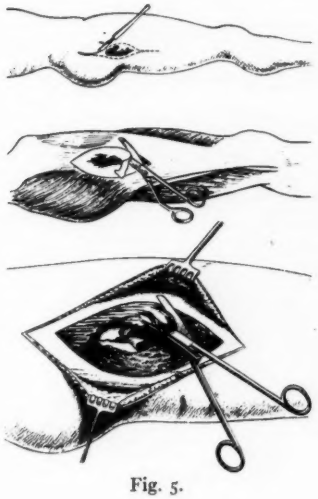
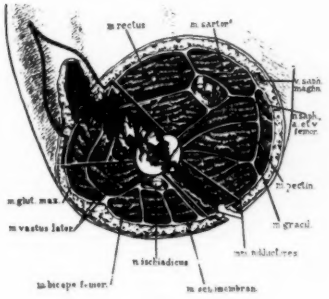


Fig. 5.



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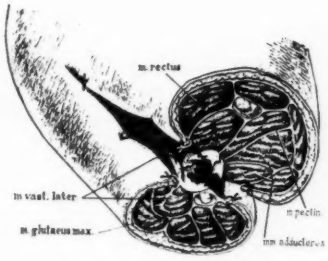


Fig. 7.

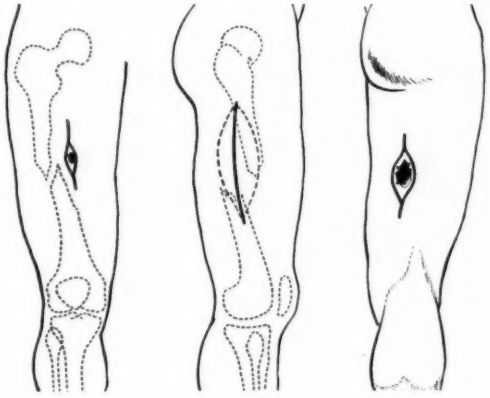


Fig. 8.

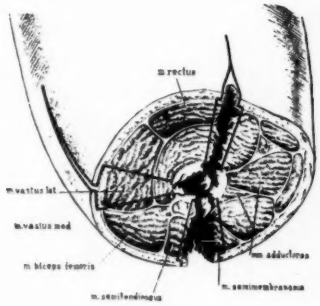


Fig. 9.

Figs. 5, 6, and 7. Method of excision and suture of the skin edges in fracture of the upper third of the femur.

Figs. 8 and 9. Method of excision and suture of the skin edges in fracture of the middle third of the femur.

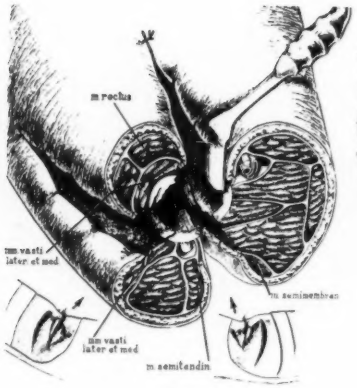
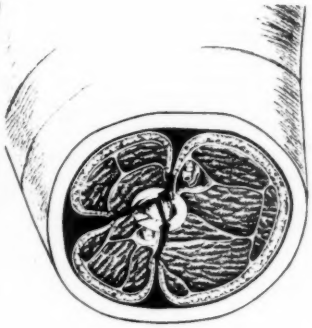


Fig. 10.



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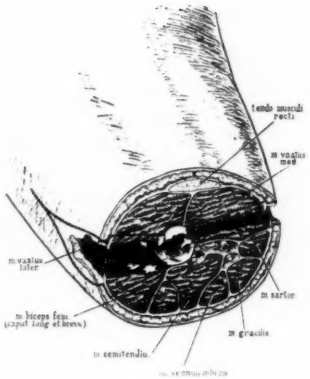
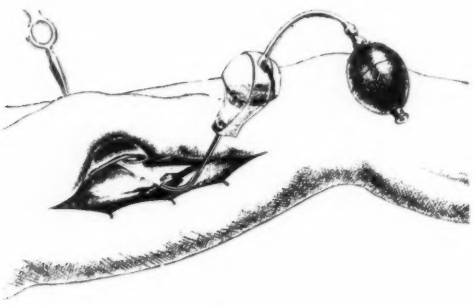


Fig. 13.



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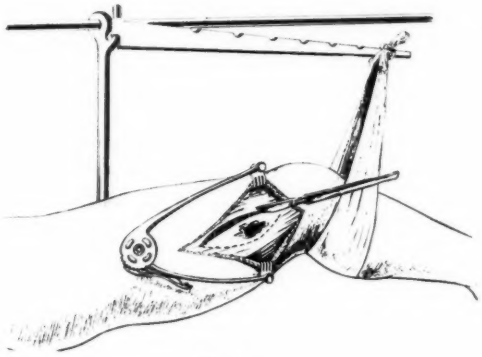

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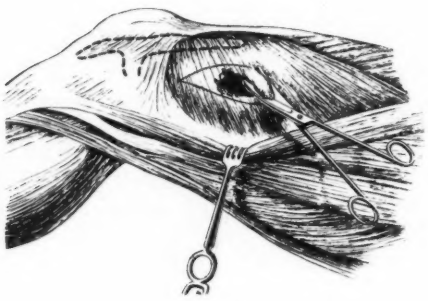


Fig. 15.

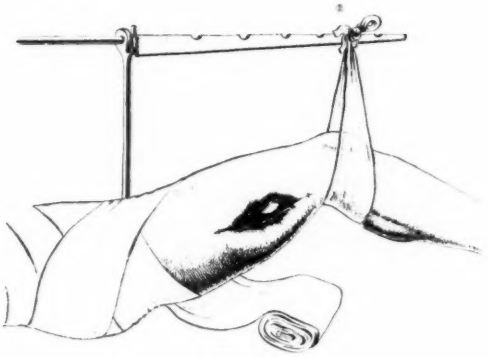


Fig. 16.

Figs. 10, 11, and 12. Method of excision and suture of the skin edges in fracture of the middle third of the femur.

Figs. 13 and 14. Method of excision and suture of the skin edges in fracture of the lower third of the femur.

Figs. 15 and 16. Method of excision and suture of the skin edges in fracture of the lower third of the femur.

Fig. 17.

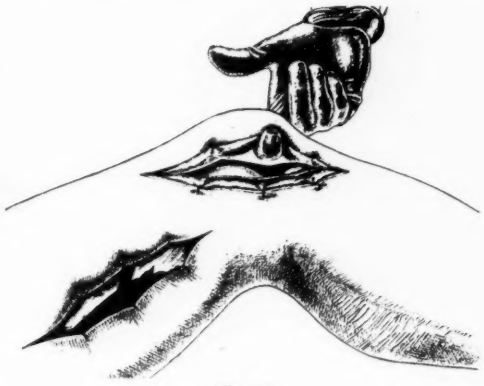


Fig. 18.

Fig. 19.

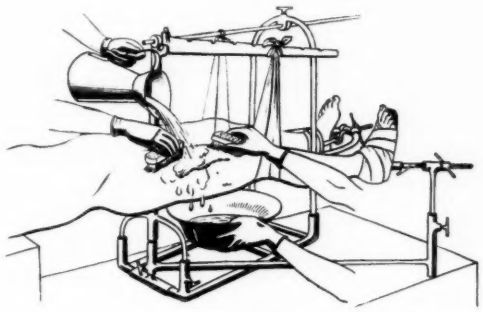


Fig. 20.

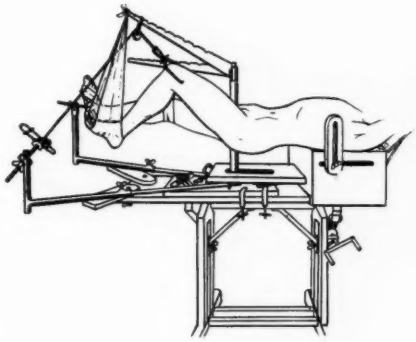


Fig. 21.

Figs. 17 and 18. Excision of the wound with suture of both skin edges and arthrostomy for injury of the knee.

Figs. 19, 20, and 21. Steps in the conveyor method used by a "thigh brigade."

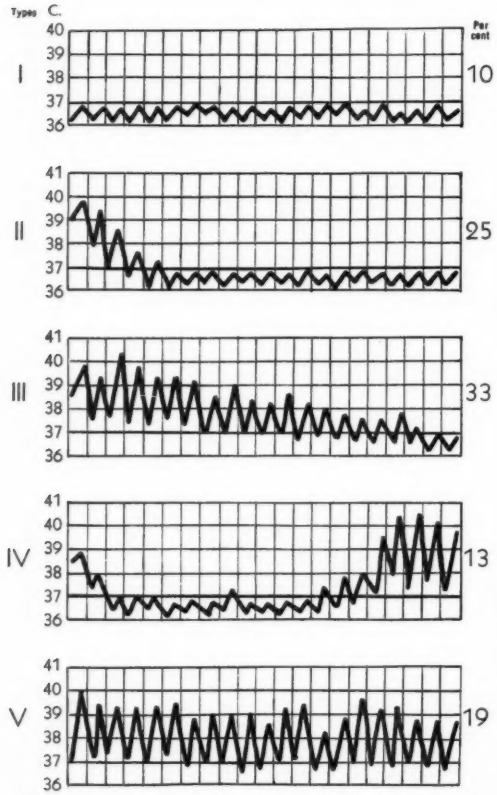


Fig. 22. Temperature curves in various clinical types of cases.

requires half an hour. At the second table the surgeon, with an assistant or an able nurse and second nurse passing the instruments, performs the operation. This step also requires half an hour. At the third table, two able nurses put on the plaster cast with one aid who moistens the bandages and rolls out the patterns. Another half hour, including the cutting

TABLE I.—TIME ELAPSED BETWEEN RECEIPT OF WOUND AND OPERATION

Time in days after wound	Per cent
The first 3	1.6
From 3 to 5	24.2
From 6 to 10	36.9
From 11 to 15	21.9
More than 15 days	15.4

The condition on arrival was satisfactory in 44 per cent; mildly grave in 37 per cent; and severe in 19 per cent.

TABLE II.—CHANGE OF THE PLASTER-OF-PARIS CAST

	Per cent
I. Absolute indications	8.0
1. Hemorrhage	2.4
2. Gas gangrene	0.0
3. Gangrene	0.0
4. Acute cellulitis	3.1
5. Sepsis	2.5
II. Direct indications	40.0
1. Continuous fever	7.4
2. Secondary rise of temperature	13.9
3. Dislocation of fragments	4.7
4. Pus soaking and soiling the plaster	14.0
III. At the proper time	17.0
IV. Complete recovery in the first cast	35.0

TABLE III.—MORTALITY IN 500 CASES OF FRACTURES OF THE THIGH TREATED BY THE CLOSED PLASTER-OF-PARIS METHOD

	Per cent
Total mortality	5.4
On the first 3 days	0.0
From 3 to 30 days	4.1
After 30 days	1.3
Causes of Death	
Secondary hemorrhage	1.6
Gas gangrene	0.0
General intoxication	0.3
Sepsis	2.9*
Tetanus	0.3
Accidental	0.3

*1.6 of these 2.9 per cent were from other hospitals in desperate state.

of the edges and inscriptions on the cast, is required.

So, every patient requires an hour and a half of time, but every half hour one properly operated upon and definitely immobilized patient both for transport and future treatment leaves such a conveyor system. In this way one surgeon with 8 aids during a 16 hour work day can pass through 25 to 30 severely wounded with fractures of the thigh.

During two days such a brigade can duly attend to all fractures of the thigh, knee, and hip joint in a thousand wounded men. If the wounded number not one but two thousand it is necessary to have two such brigades. These wounded not only receive complete surgical aid, but later they will require only food and the most simple nursing care. More than 90 per cent of the patients so treated will be able to withstand evacuation into the deep rear, quickly and in excellent condition, and half of them will recover from their wounds, with

complete consolidation of their fractures, in the first plaster cast.

INFECTED WOUNDS AND FRACTURES

Surgeons during the first World War were afraid of active interference in infected wounds, particularly those associated with fractures but we have adopted a very definite and active practice in the opposite direction. We operate upon, excise, wash, and cover with plaster cast infected wounds and fractures in a more definite way, the more evident and acute is the infection.

Table I gives some data concerning more than 500 cases of war fractures of the femur that passed through my hands during the German offensive on Moscow in the autumn of 1941 and during two great battles around Rjev in 1942. More than 80 per cent of the patients came 3 to 15 days after they were wounded; and 15 per cent even later. Among such severe and infected material amputations were performed in 12 per cent: 6.6 per cent immediately after their arrival because of lesions of large vessels, gas gangrene, and too extensive injuries with severe infection; and 5.4 per cent secondary amputations during the treatment with plaster-of-Paris cast, mainly because of a generalized septic condition. The types of temperature curves in the various clinical types of cases are shown in Figure 22. Table II shows the causes and indications which have brought about the necessity of changing the plaster cast immediately or before the required time. Table III gives the data as to mortality occurring during treatment.

As is seen, during 1941 and half of 1942 there was a mortality of 5.9 per cent. We count these results as good, the more so because at that time the general mortality in cases of war fractures of the femur in the Moscow hospitals reached 17 per cent. However, during the winter, 1942–1943, the mortality in these groups of cases in all the Moscow military hospitals decreased by 3 per cent.

PIROGOFF, quite independently of Matisen, began the treatment of fractures by using a plaster cast a year and a half before the Crimean war, i.e., at the very beginning of the year 1853. He was the first surgeon in the world who used this method in military surgery and on a very large scale during the siege of Sevastopol.

Nicolaus Pirogoff
1810–1881

Pirogoff's *The Principles of the General War Surgery*, was published in Russian and German in 1865. This is a classical work on field surgery without an equal in any country in the 19th century. Pirogoff wrote about the advantages and merits of plaster cast in war time in two other books dealing with surgery during the French-Prussian War of 1870 and the Balkan War of 1877. In a special monograph on the subject of his *Alebaster* plaster cast Pirogoff gave in full details the technique of the application of plaster casts upon the extremities particularly under wartime conditions.

"Although these fractures were always connected with considerable oedemas, etc. I treated them as well as in peace time immediately applying the plaster cast and I do not recall a single case which made me regret that I had proceeded thus; on the contrary, I remember several patients when I applied the closed plaster cast in spite of the perforation of the skin and wound healed without suppuration. . . .

Der Gypsklebeverband

bei

einfachen und complicirten Knochenbrüchen

und

in seiner Anwendung beim Transport Verwundeter und auf dem Schlachtfelde.

VON

NIKOLAUS PIROGOFF,

DR. MED., AKADEMIKER, ORD. PROF. DER CHIRURGIE AN DER MEDICO-CHIRURGISCHEN AKADEMIE IN ST. PETERSBURG, OBERARZT DER CHIRURGISCHEN ABTHEILUNG DES ZWEITEN LANDHOSPITALS, DIRECTOR DES ANATOMISCHEN INSTITUTS, WIRKLICHEM STAATSRATH UND RITTER, MITGLIED DES MEDICINALCONSEILS, CORRESPOND. MITGLIED DER AKADEMIE DER WISSENSCHAFTEN, EHRENMITGLIED DER UNIVERSITÄT DORPAT. CONSULTANT IN DEN HOSPITÄLERN OBUCHOW, PETER-PAUL UND MARIA-MAGDALENA ETC. ETC.

ZWEITES HEFT.

MIT SECHS LITHOGRAPHIRTEN TAFELN.

LEIPZIG,

DRUCK UND VERLAG VON BREITKOPF & HÄRTEL.

1854.

Fig. 23. Title page for *Der Gypsklebeverband* by Pirogoff.

"The conservative treatment is out of question for me without a complete immobilization of the fractured ends and that's why I consider the secondary malignant oedema in its acute stage to be the only counter-indication for the application of the closed cast. In cases of the primary traumatic swelling depending upon the blood extravasants, I consider the plaster cast to be the best preservative means against its further progress. . . .

"It is not of extreme difficulty to make a plaster cast; I make it by two different means; I'll mention now about the time when my plaster cast must be applied. It must be applied at the First Aid Station for transportation or in hospital for the treatment. In the first case it is applied soon after the injury before the formation of swelling and suppuration and therefore it may be made even without windows if the patient is not going to be transported too far; but in this case it is necessary to watch it during the transportation and take it off immediately when arriving at the hospital. The main thing is to keep the limb operated upon in the plaster of Paris cast."

DIVISION OF THE FLEXOR TENDONS WITHIN THE DIGITAL SHEATH

SUMNER L. KOCH, M.D., F.A.C.S., Chicago, Illinois

THE surgery of divided tendons differs from other types of reparative surgery in one important respect: not only must the sutured tissues heal so firmly that the line of union can withstand the tension that is put upon it as muscles contract, but the line of union must be so smooth that there is no interference with the free gliding movement essential for normal function. In repairing a hernia the surgeon attempts to stop bleeding completely, but he would not be unduly disturbed if some subcutaneous oozing took place that stopped short of hematoma formation and did not prevent primary healing. It is entirely conceivable that the scar tissue formation resulting from a limited extravasation of blood might add to the strength of the abdominal wall. It is upon the formation of such fibrous tissue that advocates of the injection method depend for success. The formation of similar scar tissue about a sutured tendon, however, would be sufficient to fix the tendon to the surrounding tissues and make impossible free gliding movement.

In spite of the pessimistic attitude sometimes expressed concerning the possibility of successful repair of flexor tendons divided within the digital sheath[1] good results can be secured if conditions are favorable and if the surgeon is willing to expend sufficient time and patience. Both are necessary if one is to perform a tedious task with meticulous attention to detail, and with constant care to avoid trauma to delicate tissues which must heal with little inflammatory reaction if free gliding movement is to be attained.

From the Department of Surgery, Northwestern University Medical School. Read before the Chicago Surgical Society, November 5, 1943.

[1] "When a flexor tendon within its digital sheath has been cut the conclusion reached by one of us, who has had 25 years' experience in a city in which the local trades predispose to such injuries, coincides exactly with that of Teece, who writes: 'In an experience covering some hundreds of cases of tendon injuries, I have never seen a case of successful primary or secondary suture when the point of division has actually been within the flexor sheath.' " (Bailey).

The conditions essential for success are: (1) fingers with an adequate blood supply and free from excessive scar tissue formation; (2) sufficient tendon with a smooth uninjured synovial covering; (3) a retentive mechanism to hold the tendon in contact with the volar surface of the finger when tension is put upon it; (4) normal mobility at the interphalangeal and metacarpophalangeal joints.

Each of these deserves a word of emphasis. It is hopeless to expect a sutured tendon to heal kindly and to move freely if repair is carried out in a finger or thumb narrowed and shrunken as a result of scar tissue contraction and perhaps division of digital nerves and blood vessels. After long continued infection which has traversed the tendon sheath and caused widespread involvement of the surrounding soft tissues the extensive fibrosis which invariably results becomes an insuperable barrier to the sound healing and free movement that should follow a reparative operation.

Smooth uninjured tendon with an intact synovial covering is essential because at least "half" of the gliding mechanism must be intact. As a result of tendon division the parietal layer of the synovial sheath is always injured. If hemorrhage, and still more certainly if any infection has followed the injury, the destruction of the smooth synovial lining of the digital sheath may be of wide extent. We know of no way of correcting this defect, and of no type of replacement procedure, i.e. of providing a new parietal sheath, yet devised which has given satisfactory results. We do know that if the tendon itself is covered with smooth synovial tissue free gliding movement can be retained if the repaired tendon is surrounded by fairly normal soft tissue (not necessarily synovial tissue) and no extensive inflammatory reaction occurs. The best evidence of this fact is that even after extensive removal of inflamed tuberculous sheaths that

Fig. 1. Result of immediate suture of flexor profundus of middle finger following division of both flexor tendons just proximal to web.

leaves all the flexor tendons bare and uncovered in the carpal tunnel and lower forearm the fingers can be flexed and extended with complete freedom if primary healing follows operative removal of the parietal layer of the tendon sheaths. It is hopeless, however, to expect free movement *if both tendon surface and tendon sheath are injured.* To unite scarred ends of a tendon within a finger, to attempt lengthening operations within a digit, or to free a sutured tendon which has become adherent to the surrounding tissues with the hope that early movement will prevent reformation of the scar tissue which has been divided are futile procedures, simply because they ignore the primary fact that at least one-half of the normal gliding mechanism which nature has provided must be present if free movement is to result.

Only if one can repair a tendon injury immediately after its division can one be certain of having sufficient normal tendon to permit end-to-end suture (Figs. 1, 2). Occasionally if no attempt at operative repair has been made and if the wound of injury has healed by primary union it may be possible to draw the separated ends of the tendon together without excessive tension and carry out end-to-end suture (Fig. 3). We have seen only a few cases in which this could be accomplished after a primary effort at repair had proved unsuccessful, because of the fibrosis and destruction of tendon tissue almost invariably present above and below the site of division. The advice sometimes given the surgeon to anchor a divided tendon to the surrounding tissues so as to prevent retraction and facilitate subsequent repair is ill conceived, to say the least. Such a procedure simply leads to dense scar formation which makes subsequent operation unusually difficult and jeopardizes the final result. A healthy, little traumatized tendon which has retracted into the palm can sometimes be brought distalward through an intact sheath and sutured to the distal end of the tendon, but if the tendon is fixed by sutures to the surrounding tissues it is inevitably torn

Fig. 2. Result of immediate suture of flexor profundus following division of both flexor tendons proximal to proximal interphalangeal joint. (Case of Dr. Michael Mason.)

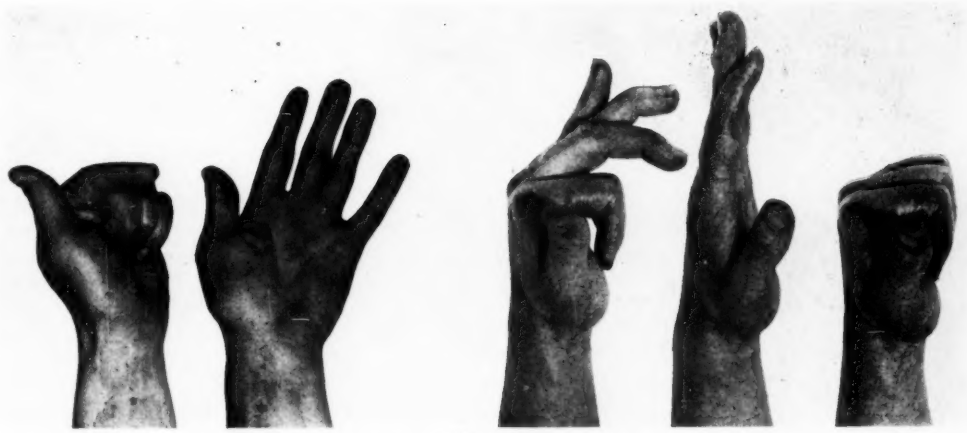


Fig. 3, a.

Fig. 3. a, Result of suture 6 months after injury of flexor profundus of index finger divided at level of proximal interphalangeal joint. Left, before operation; right, result 6 months after operation. b, Diagram showing condition before operation and restoration of tendon sheath with aid of graft from foot.

away by the constant tension to which it is subjected. The extent of the resulting fibrosis of both tendon and surrounding tissues can only be appreciated when one later attempts repair.

If the available tendon is irreparably damaged how can one provide normal uninjured tendon? Two methods are available: one, to divide the sublimis tendon through a transverse incision just above the wrist, draw it out through the palmar incision and use it to bridge the gap between the ends of the profundus; the other, to use one or two of the flat, long extensor tendons from the dorsum of the foot, since the long extensor tendons of the lateral four toes can be removed without loss of extensor function of the toes. The first method has the advantage of avoiding an additional incision over another extremity, and of providing a tendon graft which is of the same caliber and strength as the tendon ends which the graft is to unite. If the affected digit is the thumb with its single long flexor tendon, or if sublimis and profundus are so firmly fused in the palm that they cannot easily be separated one has no recourse except to use one or two of the long extensor tendons from the dorsum of the foot.

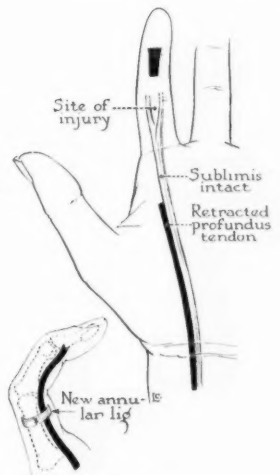


Fig 3, b.

A retentive mechanism to hold the tendon in place over the volar surface of the flexed finger and prevent it from being drawn taut like a bowstring under the palmar skin when tension is put upon it is also an essential part of the normally functioning mechanism of the finger. The synovial sheath, with its visceral layer covering the tendon and its parietal layer lining the fibrous sheath, permits gliding movement. The outer fibrous sheath holds the tendon in place over the concavity of the flexed finger as the finger is drawn into flexion. If the fibrous sheath is destroyed or if its

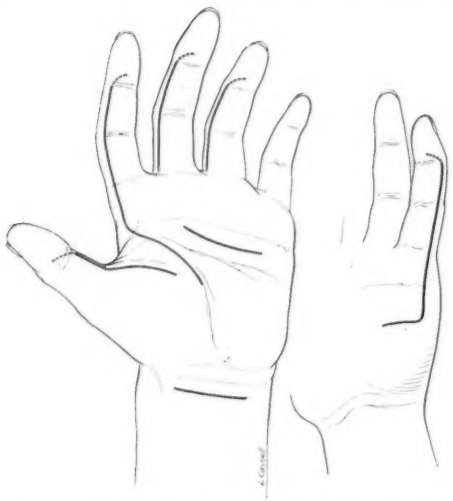


Fig. 4. Incisions for exposure and repair of divided tendons if made along flexion creases heal with minimum of scar and disabling contracture.

edges cannot be approximated without crowding the tendon unduly within a narrow space it must be replaced. If the loss of fibrous sheath is not too great it may be possible to divide it partially at one side, draw it across the tendon as a flap and suture its free edge to the corresponding fibrous tissue on the opposite side. If this cannot be done one must pass a slip of normal tendon around the finger, suture the ends and so form a new annular ligament (Fig. 11).

It is hardly necessary to emphasize the need of normal mobility at interphalangeal and metacarpophalangeal joints if tendon repair is to be followed by satisfactory function. Sutured tendons are handicapped at best. If the patient cannot bend the injured finger easily with his uninjured hand, and if it springs back into extension like a strip of spring steel when tension is released it is obvious that no sutured tendon or tendon graft could be expected to draw the finger into flexion. Often the first step in treatment of the patient with injured flexor tendons is physical therapy directed toward securing increased mobility and restoration of passive flexion at interphalangeal and metacarpophalangeal joints.

With the conditions necessary for success in mind we wish to discuss briefly the details of technique that have impressed us as of particular importance.

1. *Incisions.* Bunnell more consistently than anyone else has stressed the importance of avoiding scar contractures by making incisions along flexion creases and parallel with lines of skin cleavage, and not across them. Figure 4 indicates the incisions ordinarily used in the repair of injuries of the flexor tendons within the fingers. Through these incisions the injured tendons are exposed, freed and sutured.

Needless to say, in choosing the exact site and in determining the length of the incision, one is guided by the position of the original wound and *the position in which the hand was held at the time of injury.* If the tendons in finger or palm are divided when the fingers are completely extended the distal segments, which have no contractile power, lie close to the site of injury; the proximal segments are drawn far proximalward by the contraction of the affected muscles. If, on the other hand, the fingers are tightly flexed at the time of injury there will be relatively little further retraction of the proximal segments but the distal segments are retracted distalward for a surprisingly great distance when the fingers are extended. It is not uncommon in such a case to find the distal segment of the divided profundus at the level of the proximal interphalangeal joint even though the division has taken place in the middle of the palm.

2. *Preservation of the fibrous tendon sheath.* The fibrous tendon sheath is opened by an incision close to its attachment to the bone, never by a median incision. Even if the empty sheath is completely collapsed it may be possible to open it, save the "roof" and use it eventually as a flap to lay across the repaired tendon and hold it in place. Under such circumstances care must be used not to injure its synovial lining.

If the sheath is collapsed and its walls have become adherent to one another one must remove the "roof," preserve the "floor," and construct a new retaining mechanism.

3. *Mobilization of divided tendons.* If a tendon is frozen within its sheath it must be freed

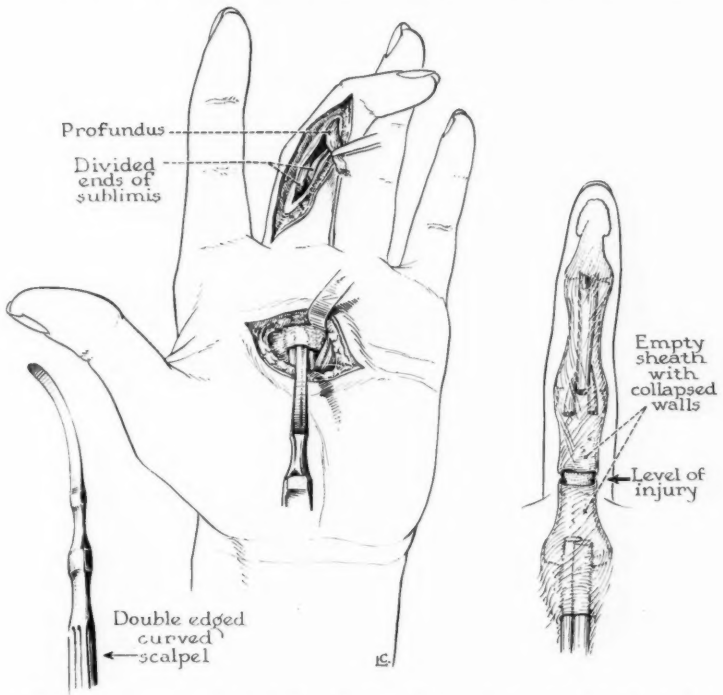


Fig. 5. Diagram showing technique of approach to and exposure of tendons when division has occurred at level of web. A curved double edged scalpel is helpful in separating the tendons from the surrounding sheath over the proximal phalanx.

with particular care to leave the sheath as nearly uninjured as possible. The greatest difficulty commonly encountered is over the proximal phalanx, and, if the original injury has been at or near the level of the web, in freeing the distal segment of the profundus from the slips of insertion of the sublimis so that the distal phalanx is easily flexed when tension is put upon the freed profundus. To free the tendons fixed within the sheath overlying the proximal phalanx we have found a double edged curved blade (Fig. 5) useful. By inserting the curved knife beneath the tendons and between tendons and overlying sheath, first by working distalward from the palmar incision and then proximalward from the incision at the side of the finger the tendons are gradually freed.

When the tendons are completely freed within the finger the proximal segment or segments of the tendons are freed within the palm. As they are drawn distalward one invariably finds they are held more or less firmly to the surrounding tissues. Fibrous adhesions are divided cleanly as far proximalward as possible. Sometimes in drawing the proximal segments of the tendons distalward a lumbrical muscle comes into view, giving the appearance of an umbrella which has been turned inside out by a gust of wind. The profundus retracting proximalward immediately after its division draws the lumbrical muscle with it. The muscle, often torn by this sudden tension, becomes adherent and more or less firmly fixed to the surrounding tissues. As the surgeon draws the retracted tendon distalward into the field of operation the level of origin of the muscle comes into view while the more distal portion of the muscle still remains fixed to the surrounding tissues. It is this condition that causes the inverted umbrella appearance. If the lum-

Fig. 6, a.

Fig. 6. a, Substitution of graft of flexor sublimis to fill defect between widely separated ends of flexor profundus of middle finger. Left, before operation; right, result 12 months later. b, Diagram showing technique of operation.

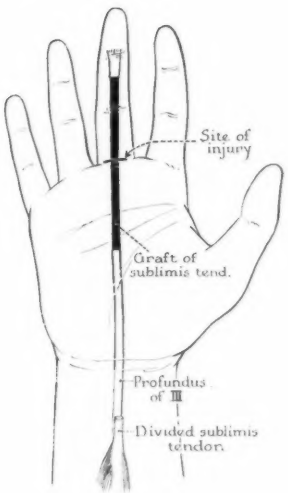


Fig. 6, b.

brical muscle has been partly or completely divided at the time of the original injury the eversion as the retracted tendon is again drawn distalward becomes complete. It may be necessary to excise a part of the lumbrical muscle so that its attachments to the surrounding tissues do not interfere with subsequent freedom of movement. In some cases a part of it can be used to cover the line of suture in the palm and form a barrier of soft tissue between sutured tendon and overlying skin.

4. *Tendon grafts to bridge defects* (Figs. 6–9). With the tendons well exposed one can determine the best method of restoring continuity. Rarely in secondary injuries is it possible to bring widely retracted segments together without excessive tension. If clean cut tendon ends cannot be approximated without abnormal tension one must use a graft to fill the defect. If one is repairing tendons of index, middle or ring fingers, unless the tendons are so completely fused in the palm that the sublimis and profundus cannot be easily separated from one another, the simplest procedure is to expose the tendons just above the wrist, divide the sublimis tendon of the affected finger and draw it out through the palmar wound. The smoother, normal proximal portion is used as the graft. If the thumb or little finger is involved, or if the two tendons of any of the other digits are fused into a single tendon one must secure the graft from the foot. In the thumb, obviously, there is no sublimis which can be utilized. In the little finger the sublimis is so small and slender that one would prefer not to use it as a graft between the ends of the considerably larger and stronger profundus. Whatever the tendon chosen as a graft one tries to leave a covering of areolar tissue attached to its surface, and not "skin it out" of its bed as it is removed. It is advantageous also to insert the stay suture in the tendon to be used as the graft before it is detached. To insert a suture with exactness in a loose slippery tendon held in moist gauze is a difficult feat.

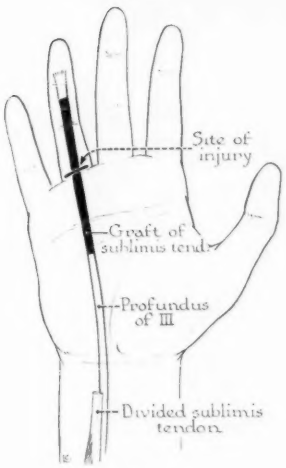
Fig. 7, a.

Fig. 7. a, Result of substitution of graft of flexor sublimis to fill defect between widely separated ends of flexor profundus of ring finger. b, Diagram showing technique of operation.

Fig. 8. a, Result of substitution of graft of flexor sublimis to fill defect between widely separated ends of flexor profundus of ring finger. b, Diagram showing technique of operation.

5. *Tendon suture.* Ragged tendon ends are cut away so that one can bring healthy clean cut ends into apposition. If a graft is used the graft is carefully drawn through the sheath overlying the proximal phalanx, and end-to-end suture of graft to the distal segment of the profundus carried out (Fig. 10). Whether for uniting tendon ends or uniting graft to tendon we have in recent years constantly used the type of suture which Mason and Allen in their extensive experimental work found to give the most satisfactory results from the standpoint of firm healing, tensile strength and freedom from irritation and foreign body reaction. They have shown that the ends of the tendon should be as free as possible from any foreign material if rapid re-formation of fibrous tissue and tendon tissue is to take place at the site of approximation. Knots between tendon ends and sutures woven back and forth close to the cut surface of the tendon act as foreign bodies, set up inflammatory reaction and cause deviation of regenerating fibers from the direct vertical line in which they should lie. For the stay suture we have used No. 6 Champion silk,

Fig. 8, a.



Figs. 7, b and 8, b.

occasionally in very stout tendons, No. 8; for edge-to-edge approximation 8 nought silk swaged on the needle (atraumatic suture).

Because of the excellent results that have been obtained with silk sutures inserted as described we have been reluctant to use steel wire, which experimentally is difficult to tie with exact tension because of its elasticity, and difficult to use without damaging rubber gloves. We have been quite unwilling to thread steel sutures through tendon ends or tendon grafts with the idea of removing them at a later date, a procedure recommended by Bunnell. If tendons can be sutured end-to-end we would be reluctant to expose any more of the tendon than necessary for insertion of the required sutures. If a graft is used it is difficult to see how a double strand of steel

Fig. 9, a.

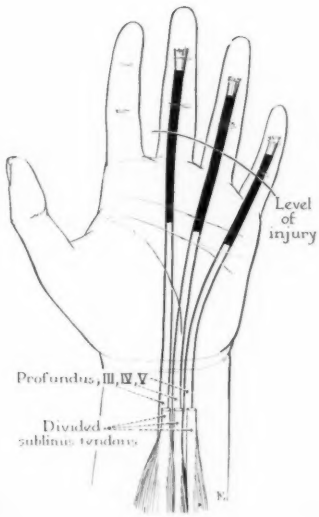


Fig. 9, b.

Fig. 9. a, Result of substitution of graft of flexor sublimis to fill defect between widely separated ends of flexor profundus of middle, ring and little fingers. b, Diagram showing technique of operation.

wire could be passed through it longitudinally without damaging the graft and its covering. To remove it without causing injury might also be difficult. Occasionally two flat tendons from the foot are used, one laid over the other, to replace a single stout flexor tendon. To thread sutures through two grafts so placed would add still further difficulties. It is our belief that we shall make progress by simplifying our surgical procedures as much as possible rather than by making them more complicated.

6. *Re-formation of the fibrous sheath.* If the line of suture lies over the middle phalanx the sheath is reconstructed as well as possible but care is taken not to lay sheath tissue too close to the line of suture. Tendons heal, as do bones, by callus formation and with moderate, if temporary, thickening at the line of union. There must be sufficient space for the thicker calloused portion of the tendon to move back and forth without any constricting obstruction. Furthermore, and in this fact we believe lies the fallacy of surrounding a sutured tendon with any type of artificial membrane, the nutrition of the tendon within the finger must come in part from the capillaries of the subcutaneous tissue which overlies it. The central artery of the tendon itself is so minute it cannot be seen with the naked eye. The blood supply of the distal portion of the tendon comes through a very small and slender mesentery. Blocking off the ingrowth of blood vessels at the line of suture jeopardizes the sound healing of the sutured tendon ends which is the first essential to restoration of function.

If the sheath tissue remaining is insufficient to hold the tendon in place over the palmar

surface of the finger as the tendon is drawn proximalward a new ligament must be provided. A simple method was suggested long ago by Bunnell (Fig. 11). A slip of tendon is passed around the phalanx at the site of maximum tension. This tendon may be one of the slips of the sublimis if the available portion is long enough to serve both as the needed graft and as an annular ligament, or it may be a graft from the foot.

With a small knife blade the soft tissue at each side of the phalanx is freed by dissecting close to the bone. With a rather sharply curved aneurysm needle a ligature is carried around the bone, and the slip of tendon tied to the ligature and drawn in place. The ends of the new annular ligament are united, preferably by overlapping them and inserting a few sutures at each side. With the sutures in place the "ring" is slipped far enough around the bone so that the sutures lie at the side of the bone and a perfectly smooth tendon surface overlies the tendon graft.

Occasionally one can lay one of the slips of insertion of the sublimis transversely across the profundus in the middle phalanx, attach the free end to the fibrous remains of the sheath tissue on the opposite side and so form a satisfactory retaining ligament. If this is not possible the method described above is the most satisfactory alternative.

7. *Closure of the finger incision.* When suture of the graft to the distal segment of the profundus and reconstruction of sheath and retaining mechanism are completed the finger incision is closed with subcutaneous sutures of fine silk and with horsehair or some similar suture in the skin. It is a real advantage to be able to close the incision in the finger while the finger is still extended and before the suture of graft to profundus in the palm is carried out. To close an incision extending along the greater part of the finger while the finger is supported in flexion and while one is attempting to avoid tension on a newly sutured tendon is a difficult task. If the thumb is the digit involved closure of the incision after suture of the tendon (i.e. when no graft has been used) is still more difficult.

8. *Suture of the proximal end of the graft to the proximal segment of the tendon.* After closure of the finger incision the final stage of the tendon suture is completed. It is difficult to estimate and state the degree of tension that will give the most satisfactory result. Our best judgment is that when the hand is flexed at the wrist to an angle of 120 to 110 degrees, and when the fingers are semiflexed at the metacarpophalangeal joints to an angle of 120 degrees, the ends to be united should come together at normal tendon tension—i.e. they should be taut, not tight and not flaccid.

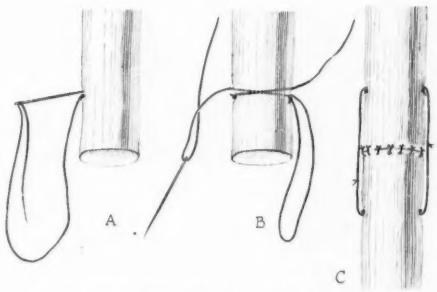


Fig. 10. Technique of end-to-end tendon suture.

SUTURE OF THE LONG FLEXOR TENDON OF THE THUMB

The position of the thumb with reference to the palm and its single flexor tendon pro-

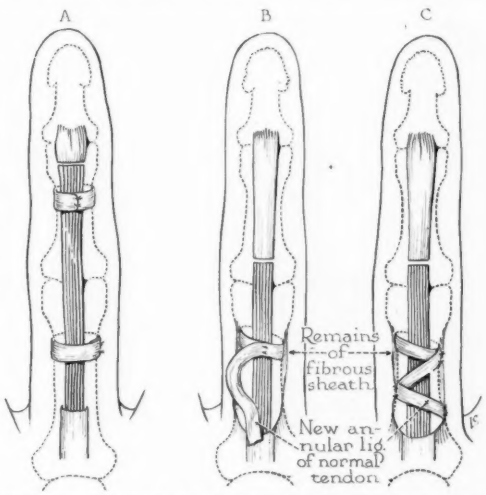


Fig. 11. Method of re-forming fibrous tendon sheath to hold flexor tendon in place over palmar surface of middle and proximal phalanges. (After Bunnell.)

Fig. 12, a.

Fig. 12. a, Result of tenolysis of flexor tendons of little finger and substitution of graft from foot to replace defect in widely separated ends of ring finger 6 months after injury. Left, flexion contracture of affected fingers before operation; right, result 2 years after operation. b, Diagram showing original injury.

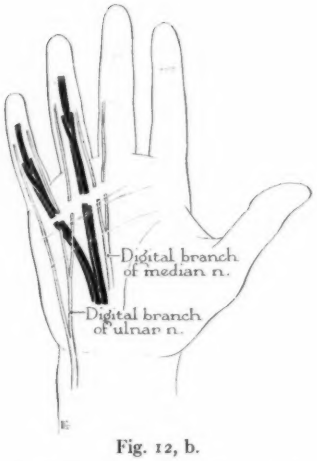


Fig. 12, b.

vide a problem slightly different from that which confronts the surgeon in uniting the tendons of the fingers. The site of tendon division is most commonly over the proximal phalanx. Often it is so close to the insertion of the tendon that it is very difficult to insert a satisfactory stay suture in the distal segment. No matter how close to its insertion the tendon is divided the proximal segment invariably retracts well above (proximal to) the metacarpophalangeal joint. Often in attempting to locate the cut end of the tendon in the palm we have been unable to recognize the sheath tissue which surrounds and covers it until the tendon was exposed above the wrist and tension put upon it.

The incision to expose the distal segment is always made on the ulnar side of the thumb and is continued proximalward just in front of the web (Fig. 4). The digital nerve on the ulnar side is identified first of all and drawn dorsalward. As the incision and dissection are continued proximalward one must exercise care not to injure the digital branch of the radial side, for the tendon and its sheath lie between the two nerves which converge into a V at or just proximal to the metacarpophalangeal joint. The surgeon is fortunate if he can recognize the slightly yellowed cut end of the tendon through its covering of sheath tissue before he reaches the angle of the V. If not he must dissect underneath (deep to) the nerves, and it is in this angle that it is difficult to distinguish sheath tissue from nerve and avoid injury of the latter. If one is in difficulty the only safe procedure is to expose the long flexor tendon above the wrist and by putting gentle tension upon it identify the covering sheath by the transmitted tug.

Rarely is it possible, except immediately after injury, to draw the separated ends together without excessive tension; in other words one must usually fill the defect with a graft from the foot. As long a graft as possible is secured so that the proximal line of suture can be placed just above the wrist. A suture line at any point along the sharply curving course of the tendon, i.e. between metacarpophalangeal joint and wrist, pre-

Fig. 13, a.

Fig. 13. a, Result of insertion of graft from foot to fill defect between separated ends of flexor profundus longus 5 months after injury. b, Technique of operation.

disposes to the formation of adhesions and limitation of movement. Invariably our best results have been secured when the graft reached from the distal segment of the divided tendon to a level just above the wrist, even though this involved a sacrifice of part of the remaining proximal segment of the tendon (Figs. 13, 14). In other words, if the line of suture of graft to tendon lies in that portion of the tendon where the pull is in a straight line rather than in that part where its direction changes, a more satisfactory result can be achieved.

After exposure of the distal segment of the tendon the proximal segment is located and drawn distalward as far as possible. If it cannot be united to the distal segment without excessive tension a guide suture is inserted in the freed tendon end and the proximal segment and suture are drawn out through the transverse incision at the wrist. The graft is drawn through the carpal tunnel with the aid of the guide suture and suture of graft to distal segment completed. Sheath tissue is laid across the graft; if necessary a new annular ligament is added and the incision in thumb and palm is closed.

One of the definite advantages again in the use of a graft is that it permits closure of the main incision with thumb extended and tissues relaxed. To close the incision in thumb and palm accurately and securely while the

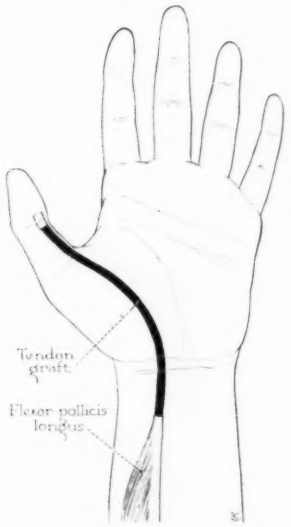


Fig. 13, b.

thumb is held flexed and the hand supported in flexion at the wrist, as is necessary if end-to-end suture of the divided segments has been carried out, is a difficult surgical feat.

If a graft is used the final step of the operation is suture of the proximal end of the graft to the proximal segment of the tendon at the wrist. Here again it is important to secure just the right degree of tension. With thumb in semiflexion at an angle of 120 degrees at interphalangeal and metacarpophalangeal joints, and hand supported in semiflexion at the wrist at an angle of 135 degrees, the ten-

Fig. 14, a.

Fig. 14, b.

Fig. 14. a, Result of insertion of graft from foot to fill defect between separated ends of flexor profundus longus. Left, before operation; right, photograph of both hands showing comparative function 6 months after operation. b, Diagram showing technique of operation.

don ends should come together smoothly, with normal tension and without any slack. Since a part of the proximal segment is sacrificed one can choose the desired tension by care to make the excision of excess tendon at the right level. After end-to-end suture of graft to tendon the transverse incision in the forearm is closed and the hand is carefully supported until the splint is applied.

SPLINTING

To immobilize an injured part so that tension on the fractured fragments is reduced to a minimum during the "critical period" of wound healing is sound surgical practice whether the fracture involves a long bone, a tendon, a nerve or the abdominal wall. It is imperative after tendon repair if one is to avoid separation of the tendon ends early after operation and extensive fibrosis and scar tissue formation in the later postoperative period. Many a surgeon has ascribed the poor results of tendon suture to adhesions resulting from failure to initiate early active movement. Mason and Allen have demonstrated the fallacy of this theory in their carefully controlled experimental study of the rate of healing of tendons. They have shown that during the immediate postoperative period (4 to 5 days) the sutured tendon ends are converted into a soft well vascularized "callus" not unlike the soft callus that unites the ends of a fractured bone. If tension is put upon the tendon during this period the sutures simply pull through the soft callus and wide separation of the tendon ends takes place. If unrestricted use is initiated at the 14th day the tensile strength at the line of suture increases rather rapidly but marked fibrosis develops and adhesions to the surrounding tissues limit very definitely the free movement of the sutured tendon.

". . . unrestricted use must be instituted late in the process and should always be preceded by active, guarded motion. Too early use of any sort is liable to lead to marked reaction and thickening which may defeat the very purpose for which it is instituted. Gliding of the healing tendon we have observed to appear in the natural course of events of the healing process. Tendons kept completely immobilized develop excellent gliding sheaths. Too early activity will not insure gliding but on the contrary will lead to increased reaction. Similarly unrestricted use even after long immobilization may cause enlargement of the tendons, stretching of the line of union and adhesions." (Mason and Allen).

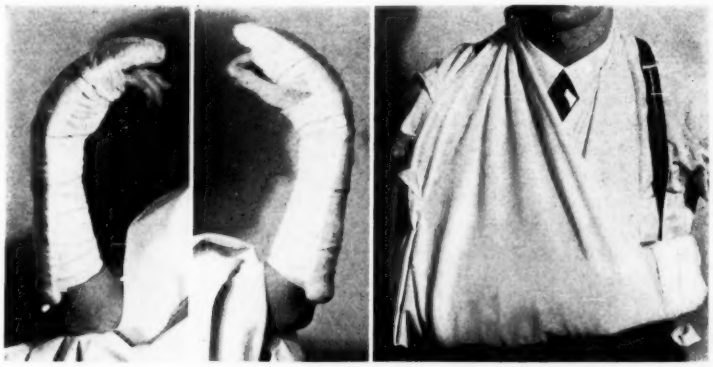


Fig. 15. Relaxation at line of suture is accomplished with aid of light aluminum splint. Flexion at elbow also helps to relax flexor tendons.

To describe the postoperative care as simply as possible we immobilize the injured hand completely for 6 to 7 days by supporting it in a splint of aluminum or plaster and keeping the forearm flexed at the elbow with the aid of a sling (Fig. 15). The original postoperative dressing is left undisturbed during this period. During the 2nd and 3rd week without change of the immobilizing splint the dressings are changed at 3 or 4 day intervals and sutures removed. Active movement *without permitting relaxation of the flexed fingers and hand* is begun at the end of the 3rd week and some relaxation of the flexed position at the end of 3½ or 4 weeks. Some support is provided in a partially relaxed position until the end of the 5th or 6th week. During the postoperative period relaxation at the line of suture is obtained by sharp flexion at the wrist and moderate flexion at the metacarpophalangeal joints, *never by flexing the fingers at the interphalangeal joints*. To suture flexor tendons in fingers or palm and attempt to secure relaxation at the line of suture by flexing the fingers around a roller bandage is almost certain to result in failure, and often leads to a permanent flexion contracture at the proximal interphalangeal joint.

Physical therapy is begun at the end of the 4th week with the purpose of stimulating the circulation by hydrotherapy and massage of the muscles involved, not of the palm or fingers, of increasing the mobility of the joints by passive movement, and of encouraging active movement. When physical therapy is begun the relaxing splint is provided with straps and buckles so that the patient can remove it and reapply it easily. He is instructed to soak the hand in warm soapy water for 10 or 15 minutes twice daily, wash it with a soft wash cloth and move the affected fingers in flexion with the help of the opposite hand, but to avoid efforts to draw the semiflexed fingers into extension. We try to make the patient realize that restoration of flexion is the important objective. Even if the fingers can never be completely extended we would not be greatly concerned if the patient could draw on a glove without difficulty and if he were able to flex them strongly and to a normal or nearly normal limit. The essential function of the fingers is to hold and grasp; the function of the extensor tendons is to extend the fingers sufficiently to permit them to secure another hold.

SUMMARY OF RECENT CASES

During a period of nearly 3 years, from January, 1941, to November, 1943, we have operated upon 46 cases of flexor tendon injury with division of the tendons within the digital sheath.[1] Only 5 of these cases were seen and operated upon within a few hours of the time of injury. One of these with an extensive crushing cutting injury with fracture of the 1st

[1] I had hoped to include a summary of cases cared for by Drs. Michael Mason, Harvey Allen, and myself during the past 10 years but have not yet been able to summarize the essential data of this group of approximately 230 cases.

metacarpal, division of all the flexor tendons in the palm except the profundus of the little finger and division of all but one of the digital branches of median and ulnar nerves was sent to the hospital for amputation of the hand. The injured structures were repaired during a difficult 5 hour operation and healing took place without infection, but with dry necrosis of skin over the thenar area between the two limbs of a V shaped flap with a distal pedicle. This patient is gradually securing restoration of function.

One patient with division of the flexor profundus just proximal to the distal interphalangeal joint resulting from an oblique laceration that left a skin flap with a distal pedicle, developed infection that subsided only when a silk suture was extruded. In 3 patients, one with division of the flexor tendon of the thumb close to its insertion and one with division of both flexor tendons, digital nerve and blood vessels of the index finger just proximal to the proximal interphalangeal joint, healing took place by primary union and excellent return of function is taking place.

In 41 cases of secondary repair it was possible to reunite the divided tendons without excessive tension in 14 cases. In 6 of these the thumb was involved, in 5 the index finger, in 1 the middle finger, in 2 the little finger. In only 3 cases had a tendon repair been attempted immediately after injury. In 27 cases of secondary repair it was necessary to use a tendon graft. In 8 cases the thumb was involved, in 5 cases the index finger, in 4 cases the middle finger, in 2 cases the ring finger, in 3 cases the little finger. In 1 case both thumb and index finger were involved; in 1 case middle and ring fingers; in 3 cases middle, ring and little fingers, were involved and repair involved implantation of a graft in each finger (Fig. 9). In 11 of the cases in which a graft was required a tendon repair had been carried out immediately after the injury and in 2 cases several operations had been performed. Of the 41 cases of secondary repair healing took place by primary union in all but 3 cases. In 2 of these a thin serous discharge persisted for a week after removal of the sutures from what appeared to be a healed wound. In the second, swelling and redness of the palm appeared first 15 days after operation, and on the 19th day a flocculent collection of pus was evacuated from the palmar incision through which the tendon graft had been united to the proximal segment of the profundus of the ring finger. Wound discharge diminished rapidly and the wound was dry on the 28th day. In neither case was any suture material extruded.

CONCLUSIONS

If the surgeon is willing to exercise care to avoid trauma to vulnerable tissues, and the patience that is required for a tedious operation and for painstaking care during the postoperative period; and if the patient is willing to co-operate with a skillful physical therapist when the necessary period of immobilization is completed good results can be obtained after division of the flexor tendons within the digital sheaths.

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THE RE-ESTABLISHMENT OF ESOPHAGOGASTRIC CONTINUITY FOLLOWING RESECTION OF ESOPHAGUS FOR CARCINOMA OF MIDDLE THIRD

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IT is fair to state that, following a fairly extensive trial by numerous surgeons throughout the country during the past 7 or 8 years, the operation of transthoracic resection and esophagogastric anastomosis for squamous cell carcinoma of the distal esophagus and adenocarcinoma of the cardiac end of the stomach, has been generally accepted as a more or less standardized procedure and that it has withstood the scrutiny of careful follow-up studies. As has been emphasized in previous papers on the subject, this has been made possible first, by a more thorough knowledge of the physiological changes that occur during open thoracic operations and the employment of methods to counteract any harmful effects of these changes; second, by the great advances in recent years in the science and art of anesthesia; third, by refinement in the technique of suture methods applied to the esophagus; and, finally, by the application to the esophagus of the principles of good cancer surgery already known and employed in other parts of the body, namely, free exposure, wide resection of the cancer-bearing focus and removal of all the associated lymph nodes. With proper selection of cases and increasing experience in the technical maneuvers of the operation, it may be confidently predicted that the operative mortality will gradually fall to a reasonable level and that many more patients will be restored to a normal useful life.

The story of cancer of the middle third of the organ has, to the present writing, not presented as encouraging an outlook. The operation always employed was that described by Torek in 1913 or the modification of it that I reported a few years ago. Essentially this involved resection of the entire thoracic esophagus, the formation of an esophagostomy stoma on the upper anterior chest wall and the connection of this stoma and the gastrostomy or lower esophagostomy by a rubber tube. In order to obviate the use of an artificial rubber esophagus, attempts have been made to reconstruct a skin-lined esophagus on the anterior chest wall, the so called antethoracic esophagoplasty. The latter requires numerous time-consuming stages which are always attended by the risk of sloughing of skin flaps, infection, fistula formation, etc. I was never satisfied with this operation for cancer of the middle third of the organ because it was necessarily makeshift in character and left the patient with a rubber mechanism which was both distasteful and subject to mechanical difficulties.

Other surgeons, too, have frequently voiced their dissatisfaction with the Torek operation and some of them have attempted to devise procedures to take its place. The pioneer in this respect was Lilienthal who devised a very ingenious operation consisting of a posterior extrapleural approach and the utilization of a skin flap from the back to bridge the defect in the organ following the removal of the cancer-bearing portion. In the light of our present knowledge of the pathological aspects of the disease, the objections to the Lilienthal operation are that the exposure was not free enough and that the operation was not radical enough. Other operations have been suggested, and some have been carried out in the experimental laboratory and a few on the human. These vary from the utilization of tubes made from the stomach wall to loops of small bowel or even segments of colon. It is immediately apparent, after careful scrutiny, that the utilization of a loop of small intestine to form a new esophagus intrathoracically is fraught with

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Fig. 1. Roentgenogram of esophagus showing an irregular stenosing lesion at the level of the 8th thoracic vertebra.

great danger from the standpoint of blood supply of the transplanted loop. I believe that such an operation in the human is neither technically feasible nor desirable.

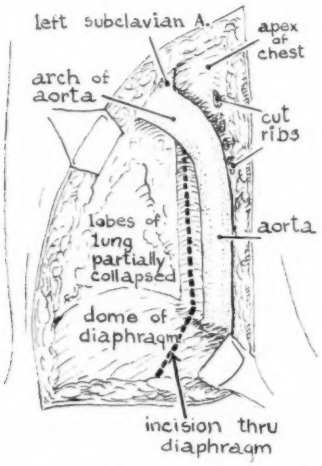

Fig. 3. Diagrammatic view of contents of left thoracic cavity, indicating incision in mediastinal pleura and left leaf of diaphragm.

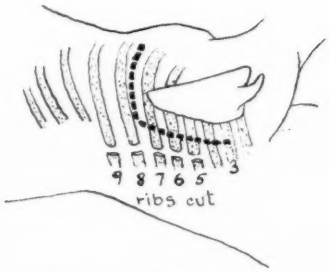

Fig. 2. Diagram showing skin incision and the site of section of the 9th, 8th, 7th, 6th and 5th ribs, thus affording adequate exposure.

Recently, Kay reported a two stage operation which makes use of a tube fashioned from the greater curvature of the stomach after the method of Jianu. At the first operation a long tube of stomach extending from pylorus to cardia is fashioned along the greater curvature, the pedicle being located near the cardia. The tube is pushed into the left pleural cavity so as to lie on the upper surface of the diaphragm. At the second stage, 10 to 14 days later, the left chest is opened and, *if an operable lesion is demonstrated*, the esophagus is excised and the previously prepared gastric tube is anastomosed to the stump of the esophagus. The main objection to this plan is quite obvious when applied to the human: before it is determined whether or not the esophageal carcinoma is operable, the patient is subjected to the risks of an operation of considerable magnitude—the first stage—aside from the fact there is a possibility the gastric tube may slough. If an inoperable lesion is demonstrated at the second stage, then the first procedure has been for naught. If one were able to predict an operable neoplasm beforehand, then Kay's procedure would have great merit and might very well be the answer to the treatment of cancer of the middle third of the esophagus.

For the past 2 years, I have had a different plan in mind and, by anatomical studies, have been attempting to determine its feasibility of its use in the human. After it seemed that there would be a reasonable chance of success, the operation was performed upon a patient for the first time in May of 1943, and the patient came through with minimal disturbance.

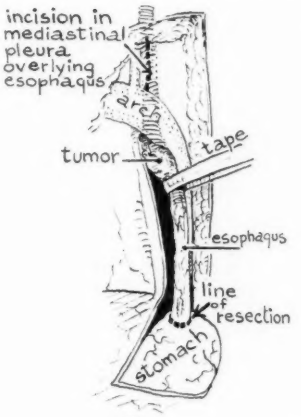

Fig. 4.

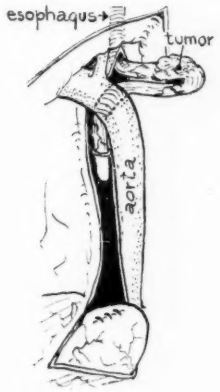

Fig. 5.

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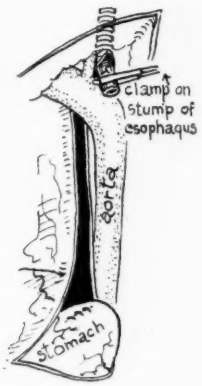

Fig. 7.

Fig. 4. The esophagus has been freed from the mediastinum from arch of aorta downward. The supra-aortic mediastinal pleura has been incised. The tumor has been freed from its attachment to the aortic arch.

Fig. 5. The supra-aortic portion of the esophagus has been mobilized and the entire organ is being drawn upward from behind the aortic arch. The cardiac end of the stomach has been doubly inverted with silk sutures.

Fig. 6. The pulling through procedure has been completely accomplished and the mobilized organ rests over the aortic arch.

Fig. 7. The esophagus has been divided well above the tumor and the stump is guarded by a small noncrushing clamp covered with soft rubber. This is necessary in order to minimize contamination from the highly infectious esophageal contents.

TECHNIQUE

The operation, applicable for cancers of the esophagus situated in the middle third, i.e., behind or just below the arch of the aorta, consists of a left transthoracic resection of the entire esophagus up to the upper border of the aortic arch and down to and including the cardia, mobilization of the upper two-thirds of the stomach by a precise ligation of its upper vessels, the transplantation of the stomach toward the apex of the chest over the arch of the aorta and the performance of an anastomosis between the esophageal stump and the stomach cephalad of the aortic arch near the apex of the chest. In spite of the fact that our patient presented a long thoracic cavity, it was surprising to see with what ease the stomach could be brought to the apex of the chest without tension and without interference of its blood supply.

This experience has demonstrated that the main problem is not that of bringing the stomach to the thoracic apex but is one concerned chiefly with the blood supply of the esophageal stump and of the stomach. Careful anatomical studies have shown that the main, if not the only, arterial supply of the supra-aortic portion of the esophagus is through small branches of the inferior thyroid artery. Apparently, the nutritional integrity of this portion of the organ is adequately cared for by these vessels if the esophagus is not separated

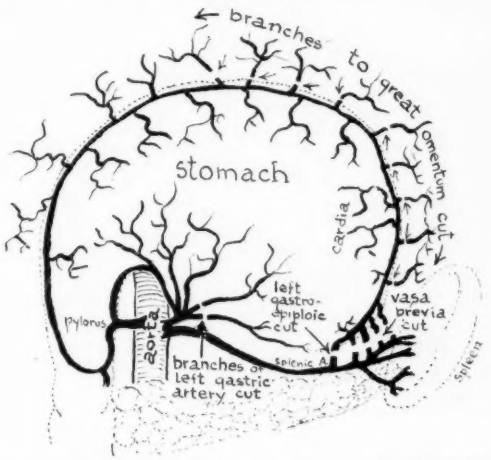

Fig. 8. Diagrammatic sketch of the blood supply of the stomach (turned upward), indicating the precise ligation of the vessels supplying the upper half of the organ. In the case reported, the upper two branches of the left gastric artery were divided.

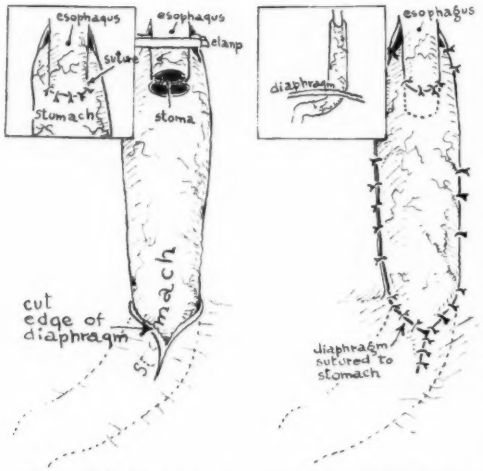

Fig. 9. Left, The stomach, now appearing greatly elongated, has been drawn upwards over the arch of the aorta and an end-to-side anastomosis is being effected between the stump of the esophagus and the anterior wall of the stomach. Insert shows completion of the two layer anastomosis.

Fig. 10. Right, The esophagus has been telescoped into the stomach to eliminate tension on the suture line. The transplanted stomach is sewn to the mediastinal pleura and to the cut edges of the diaphragm which is then sewn up to the transplanted stomach. Insert shows completed procedure.

too extensively from its upper mediastinal attachments and if kinking of the organ is carefully avoided. There may be anatomical variants in these vessels, but, apparently, they are quite unusual, and, of course, unpredictable.

The blood supply of the upper stomach is also an important item in the success of the operation. Inasmuch as it is not necessary to remove any more than the cardiac end of the organ, more of the stomach becomes available for transplantation than is the case with adenocarcinoma of the cardia in which case a wider resection must be done, thus requiring ligation of the main left gastric artery. In the case reported herewith, it was demonstrated that it was necessary to ligate *only* the upper two branches of the left gastric artery as it fans out along the lesser curvature. I believe that, if the main vessel were ligated, the blood supply of the upper end might be seriously jeopardized. Along the greater curvature, the vasa brevia vessels and the left gastroepiploic artery and branches down to the middle of the greater curvature may be safely divided in order to secure adequate mobilization. It seems important to stress, therefore, that the problem in this operation is not that of bringing the stomach to the apex of the chest but one of blood supply of the two organs the surgeon wishes to join together. He must, therefore, exert every care to insure adequate nutrition of the two structures in order to prevent necrosis and a certain fatal issue.

There are many pertinent questions that arise with respect to the later effects of this operation upon the patient. Will there be any effect on the cardiovascular apparatus incident to the new position of the stomach? Will regurgitation of gastric contents occur and to what degree? Will distention of the stomach disturb pulmonary activity or respiratory physiology? Will digestive disturbances result from the new unusual position of the stomach? The answers to these and other problems that may arise will form the basis of a subsequent report. Suffice it to say that, so far, no untoward symptoms have developed. The operation is reported as a feasible solution to the problem of cancer of the middle third of the esophagus, one which eliminates artificial swallowing devices and restores the normal act of deglutition.

CASE REPORT

Hospital No. 504,810. B. A., a 58 year old Lithuanian elevator operator was admitted to the Mt. Sinai Hospital on April 30, 1943, complaining of dull pain in the anterior right chest region for 3 months and difficulty in swallowing for 3 weeks prior to admission. The dysphagia was progressive; solid foods were regurgitated and he was able to swallow only liquids when admitted. The patient lost 15 pounds during the 3 month period.

Examination showed a well developed, fairly well nourished male. No enlarged nodes were felt in the neck. The heart and lungs were negative. Blood pressure was 110/70. Abdominal and rectal examination was negative.

Laboratory studies disclosed hemoglobin, 95 per cent; white blood cells, 10,600; segmented forms, 76 per cent; lymphocytes, 11 per cent; monocytes, 7 per cent; basophiles, 3 per cent; and eosinophiles, 3 per cent. The urine was negative; the blood Wassermann, negative; the blood urea nitrogen was 13 milligrams per cent; total protein, 6.2 per cent; vital capacity, 3,800 cubic centimeters.

Esophagoscopy revealed a circular stenosis with coarse, nodular margins 35 centimeters from the upper incisor teeth. The biopsy specimen was reported

as showing infiltrating anaplastic carcinoma in the submucosa. Bronchoscopy was performed and was negative.

The barium meal examination showed "an irregular stenosing lesion of the midesophagus at the level of the 8th dorsal vertebra. About it was a soft tissue mass. There was moderate dilatation of the esophagus above." X-ray examination of the chest showed no abnormality. The electrocardiogram was normal.

Preoperative preparation consisted of (1) high caloric liquid diet, (2) daily cleansing irrigations of the esophagus, (3) oral administration of sulfanilamide for 3 days prior to operation.

Operation was performed on May 8, 1943, 9 days after admission. Positive pressure cyclopropane anesthesia was used. An incision was made in the 7th interspace and continued upward close to the spine. Incision was deepened, the musculature was divided, and the chest cavity was entered through the 7th space. The 7th, 6th, and 5th ribs were divided close to the spine. In order to permit a more free exposure at the lower part of the chest, the 8th and 9th ribs were also divided to form a T-shaped incision of the thoracic cage. A rib spreader was inserted, and the following pathology was demonstrated: There was a large lymph node lying on the anterior and mesial aspect of the aorta about 1 inch below the neoplasm which was located in the middle third of the organ, its upper border being situated about ¼ inch below the under surface of the aortic arch. The lymph node was freed from the adventitia of the aorta and left attached to the esophagus. The esophagus was now freed from the mediastinum, the tumor bearing portion being separated eventually from the adventitia of the aorta to which it was intimately connected. The tumor measured about 2 inches in length and was stony hard in consistency. It was freed from the mediastinum without perforation of the right pleura. A radial incision was made in the diaphragm from the hiatus outward. The phrenic artery was ligated. There was found another node at the esophagocardiac junction on the lesser curvature side. This measured ½ inch in diameter. A third node of the same size was found on the superior border of the pancreas near its tail. A hand inserted into the abdomen was able to palpate the preaortic tissues and no further node enlargement was found. It was decided to attempt an anastomosis between the stomach and the esophagus above the arch of the aorta. The vessels along the greater curvature of the stomach were ligated and divided as far down as the middle of the greater curvature. The left gastric artery was not divided at its origin but its upper 2 branches along the lesser curvature were isolated and cut between ligatures. This was done in order to insure adequate blood supply of the upper stomach following its transplantation. The lymph node and the surrounding tissues were removed from the tail of the pancreas. The cardiac end of the stomach was cut across between clamps below the node described and the upper end of the stomach was closed over with two layers of silk. The stump of the esophagus was covered over with a rubber dam. It was now found that the stomach could be drawn into the chest as far as the apex, without tension. The esophagus was bluntly dissected free from the space between the arch of the aorta and the left main bronchus and drawn upward so as to lie completely above the arch. After the pleural cavity was

Fig. 11. Roentgenogram taken 5 weeks after operation showing position and size of transplanted stomach and site of anastomosis.

padded off, the esophagus was divided between clamps well above the upper edge of the tumor and the specimen was removed. The stomach was now brought over the arch of the aorta, and a careful 2 layer suture anastomosis was effected between the end of the esophagus and the anterior wall of the stomach just beyond its upper inverted end. Interrupted silk sutures were used. The stomach was telescoped over the suture line and anchored both to the esophagus wall and the adjacent pleura. The stomach below the anastomosis as far as the diaphragm was anchored to the pleura with interrupted sutures of silk on both sides. Five grams of sulfanilamide was placed in the mediastinum and the diaphragm was sutured around the transplanted stomach, its cut edges being sewn to the stomach wall. The phrenic nerve was pinched to paralyze the diaphragm. A tube was placed in the subjacent intercostal space for underwater drainage and the wound was repaired in the usual manner.

The operation required 3 hours, and the condition of patient was excellent throughout procedure; the anesthesia proceeded without incident. One thousand cubic centimeters of blood was given during the course of the operation.

Pathological examination of the excised specimen disclosed an infiltrating immature squamous cell carcinoma of esophagus with involvement of lymph nodes. The peripancreatic node showed metastatic carcinoma.

After operation patient was placed in an oxygen tent for the first 4 days. There was no respiratory distress. The highest temperature was 102.6 degrees F. and occurred on the 8th day. It reached normal on the 12th day. The underwater tube drained in decreasing amounts until the 7th day, when it was removed. The operative wound healed *per primam* and the sutures were removed on the 9th day. Sulfadiazine was given intravenously until the 3rd postoperative day. Swallowing of sips of water was first permitted on the 4th day and the food intake gradually increased thereafter until by the 14th day the patient was eating all forms of soft food, including scraped beef, without difficulty of any sort. When discharged on the 18th postoperative day he was observed eating, with considerable relish, the following: tomato juice, 4 ounces, scraped beef, puréed peas, mashed potatoes, melba toast, custard and milk.

NOTE:—The patient was last seen at the follow-up clinic on October 7, 1943. He had gained 15 pounds in weight and felt well. He was able to partake of all foods provided the swallowed bolus was not too large. Regurgitation of gastric contents in the recumbent position was minimal and was controlled by sleeping on 2 pillows. There were no cardiovascular symptoms.

GANGRENE COMPLICATING FRACTURES ABOUT THE KNEE

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VASCULAR complications following fractures about the knee are dependent upon certain anatomical relationships of the main vessels to the femur and to the tibia and fibula. The site of the fracture rather than the degree of displacement is the important factor.

In a review of the cases seen in civil life up to 1933, Dodd listed 20 cases of gangrene following fractures in the period 1850 to 1900. The series included all the extremities. Laceration of the vessels occurred in 7 cases, and thrombosis of the main artery in the remaining 13 cases. In the period 1900 to 1914 there were 6 cases reported, and laceration of the main vessel occurred in an equal proportion compared to thrombosis. In the period 1918 to 1933 there were 11 cases reported. Thrombosis of the main artery occurred in all the cases but one which was diagnosed traumatic arterial spasm and recovered without an amputation.

Von Susani reported 4 cases in 1933. Three of his cases were fractures of the proximal tibia and 1 a fracture of the distal tibia. Two patients were treated by incision of a rapidly forming hematoma, and there resulted an infection with subsequent gangrene. No anatomical dissections were performed so one can only surmise that, because of the rapidly forming hematoma, he was dealing with a laceration of the vessels.

Fitte (5) in 1935 reported 1 case in which a fracture of the mid-third of the femur resulted in a thrombosis of the popliteal artery with subsequent gangrene of the leg up to the knee. In 1938 Fitte (7) reported another case of gangrene of the foot following a fracture of the distal third of the tibia and fibula. Dissection revealed a thrombosis of the vessels in the region of the fracture. Again in 1939, Fitte (6) reported a case of gangrene, resulting from a fracture of the distal tibia, which dissection revealed as a thrombosis of the vessels.

Ottolenghi and Spinelli in 1939 reported 1 case of a fracture of the mid-third of the tibia with subsequent gangrene, which dissection proved to be a thrombosis of the arteries.

Slullitel in 1941 reported 2 cases of gangrene. One case was that of thrombosis following fracture of the tibia, and the other case that of thrombosis following fracture of the head of the fibula.

During the last 12 months there have been 4 cases of gangrene following fractures about the knee treated by the orthopedic staff at this hospital. The first case was that of a fracture of the proximal tibia with a fracture of the head of the fibula.

CASE 1. The patient, L. F., a 39 year old colored female was injured when struck by an automobile Examination on entrance revealed no gross deformity of the knee, and there was no sign of vascular embarrassment. X-ray examination (Fig. 1) revealed a fracture of the proximal end of the tibia and a fracture of the head and neck of the fibula. A Steinmann pin was placed through the os calcis, reduction was performed and a long leg cast applied. The next day the toes were cold and anesthetic to pinprick. The cast was opened anteriorly but the anesthesia persisted, the toes became discolored, and dry gangrene became well developed so that 10 days later a definite line of demarcation could be seen just above the ankle. An amputation 6 inches below the knee was performed on the 20th hospital day.

Examination of the amputated leg revealed a gangrenous foot sharply demarcated by friable tissue at the level of the malleoli. The foot was dry, black, and wrinkled. Cut section below the demarcated area showed necrotic tissue. The vessels were traced and found to be occluded, about 2 inches above the area of demarcation, by thrombi.

The mechanism of the occlusion was thought to be that of thrombosis of the vessels at the level of the bifurcation of the

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Fig. 1. Lateral and anteroposterior roentgenograms of the knee in Case 1, demonstrating a fracture of the proximal tibia and a fracture of the head and neck of the fibula.

Fig. 2. Anteroposterior and lateral roentgenograms of the lower half of the femur, Case 2, revealing a comminuted fracture of the distal third of the femur.

Fig. 3. Anteroposterior roentgenogram of the knee in Case 3 showing a fracture of the lateral tibial plateau and a fracture of the head of the fibula.

popliteal artery due to the injury to the intima, with the thrombi becoming loose in the vessels and traveling distally as emboli.

CASE 2. Comminuted fracture of the lower third of the femur. The injury was sustained when the

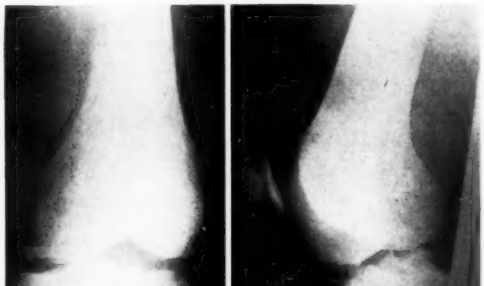

Fig. 4. Anteroposterior and lateral roentgenograms of the knee in Case 4. There is a fracture of the tibial and femoral articular surfaces with a posterior and medial dislocation of the tibia.

Fig. 5.

Fig. 6.

Fig. 8.

Fig. 5. An actual dissection of the popliteal fossa. The skin has been reflected and the fat excised thus exposing the popliteal artery and the muscular boundaries of the fossa.

Fig. 6. An actual dissection of the popliteal fossa. The biceps femoris muscle and the semimembranosus muscle have been widely reflected and the fusion of the two heads of origin of the gastrocnemius muscle opened, thus exposing the course of the popliteal artery in the popliteal fossa.

Fig. 8. An actual dissection of the anterior tibial artery. The tibialis anterior muscle has been reflected, this exposing the course of the anterior tibial artery through the hiatus between the neck of the fibula and the proximal tibia.

patient, J. S., a 38 year old white male, was thrown from an automobile. He entered the hospital in a critical condition due to a severe head injury, and in traumatic shock. Examination revealed a fracture of the lower third of the femur with a small puncture wound on the medial side of the thigh. The area about the fracture site was diffusely distended with blood. The leg below the knee was pale and cold. The pulsation of the dorsalis pedis artery was absent, and the leg was anesthetic to painful stimuli. X-ray examination (Fig. 2) revealed a comminuted fracture of the lower third of the femur. Reduction of the fracture was accomplished by the use of skeletal traction through the tibial tubercle and the reduction was maintained by a Boehler frame. He was given several transfusions, but his condition remained unimproved. The leg became mottled and gangrenous below the knee with multiple bleb formation. A midthigh amputation was performed on the 18th hospital day, but the patient did not respond to therapy and expired on the 20th hospital day.

Examination of the amputated leg revealed a black, gangrenous leg up to the level of the knee. The tissue from the knee to the point of amputation at the midthigh was necrotic and infected, and the muscles were diffusely infiltrated with blood. Dissection of the vessels revealed a complete laceration of the popliteal artery at the level of the fracture.

CASE 3. A so called "bumper-fracture." The patient, L. J., a 49 year old white male, sustained the

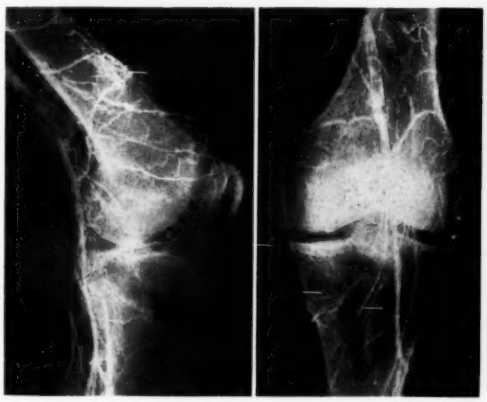

Fig. 7. Lateral and anteroposterior roentgenogram of the knee following the injection of an opaque media into the lumen of the popliteal artery.

fracture after being struck by an automobile. He entered the hospital complaining of severe pain in the region of the knee. Examination revealed a fracture of the tibial plateau with lateral instability of the knee. The foot was cold and cyanotic, and the pulsation of the dorsalis pedis artery was absent. Sensation was impaired in the foot, but pinprick caused severe pain in the leg. There was a loss of muscle power in the foot. X-ray examination (Fig. 3) revealed a fracture of the tibial plateau, and a fracture of the head of the fibula. Passive vascular exercises were immediately instituted by a sealed glass boot, warmth was obtained by the use of the light cradle, and 1/150 grain atropine sulfate grains and 1 grain copavin were given every 4 hours. The light cradle was continued until the next day at which time the extremity was then kept refrigerated. The skin became progressively more mottled, and a definite line of demarcation developed below the knee. A supracondylar amputation was performed on the 6th hospital day.

Examination of the amputated leg showed a dry gangrene of the foot, and a purplish discolored leg with numerous blebs extending up to the knee. Dissection of the vessels revealed thrombosis of the popliteal artery proximally up to the level of the amputation.

Case 4. Fracture-dislocation of the knee. The patient, K. W., a 24 year old white male, sustained the injury by being blown from a boat by an explosion. He entered the hospital in rather severe shock, and in severe pain. Examination of the leg revealed a posterior dislocation of the knee, and a marked distention of the popliteal fossa. The foot was pale, but the leg dusky in color. Pulsation of the dorsalis pedis artery was absent, and there was a loss of sensation below the knee. X-ray films (Fig. 4) revealed a fracture of the tibial articular surface with a posterior and medial dislocation of the tibia. Surgical exploration was advised but refused. Kirschner wires were placed through the tibial tubercle and the os calcis in an attempt to reduce the dislocation. A light cradle was used to apply warmth. There was an increase in the mottling, and 3 days later the leg was gangrenous. On the 4th hospital day a Callander type of supracondylar amputation was performed.

Examination of the amputated leg revealed a well developed gangrene of the foot, and a purplish discolored leg with numerous blebs up to the knee. The muscles around the knee were diffusely infiltrated with blood. Dissection of the popliteal artery revealed a ragged laceration of the proximal end of the vessel.

The anatomical dissections demonstrating the proximity of the vessels to the femur and to the tibia and fibula, as well as the restraint of the vessels by the muscles and fascia are shown in the accompanying plates. The first dissection (Fig. 5) is of the popliteal fossa and demonstrates the restraint of the popliteal artery by the muscular boundaries of the fossa. The diamond shaped boundaries are formed superiorly by the biceps femoris muscle laterally, and the semimembranosus muscle medially. Inferiorly it is bounded by the two points of origin of gastrocnemius muscle on medial and lateral femoral condyles.

The second dissection (Fig. 6) is following the reflection of the biceps femoris, semimembranosus, and gastrocnemius muscles. It demonstrates the proximity of the popliteal artery to the lower femur, and the course through the intercondyloid fossa where it is restrained by the femur anteriorly, medially, and laterally, and by the gastrocnemius muscle posteriorly. In addition, the anastomotic network of the genicular arteries acts as a restraining factor.

The factors that tend to enhance the occurrence of vascular complications in fractures about the knee, as demonstrated in the dissections just described should be emphasized. The proximity of the artery to the bone, as seen in Figure 7, is paramount in importance in the case of fractures, as jagged fragments may easily traumatize or lacerate the artery. Also, a vessel that is restrained or "locked in place" by the muscles, fascia, and anastomotic vessels is more likely to be traumatized or torn in fractures or dislocations with even a minimum displacement.

The next dissection (Fig. 8) is the course of the anterior tibial artery seen after reflecting the tibialis anterior muscle. After the bifurcation of the popliteal artery, the anterior tibial artery proceeds anteriorly through a hiatus bounded by the head and neck of the fibula laterally, the interosseous membrane inferiorly, and the proximal tibia medially and superiorly. From the dissection it can be seen that the limitations imposed on the vessel are extreme, and that we again have a markedly restrained vessel that is exposed to trauma by a fracture of the bones entering into the formation of the hiatus. Thus, a fracture of the head or neck of the fibula, or a fracture of the proximal tibia, may traumatize the vessel and initiate a vascular complication.

The early diagnosis of a vascular complication is of utmost importance, as therapy must

be instituted immediately so that irreparable damage does not occur due to the ischemia. First, there is an alteration of sensation from the normal below the point of injury. The patient may complain of severe, constant pain in the leg, or, on the contrary, there may be anesthesia of the extremity. Second, there is a blanching cyanosis, or duskiness to the extremity which is readily seen when compared to the other extremity. Third, there is a muscular paralysis below the point of vascular injury. The patient is unable to move his toes, or his foot. Fourth, the extremity is "stone" cold. The extremity is usually dry, and cadaveric to the touch. Fifth, there is an absence of pulsation of the main vessels in the extremity. Sixth, there may, or may not, be pain and tenderness over the main vessel at the site of the vascular trauma. Finally, in addition to the above, if there is a laceration of the vessels, there occurs a hematoma at the site of the laceration. This hematoma occurs more rapidly than a hematoma associated with an uncomplicated fracture, and increases in size, even dissecting up and down the muscle and fascial sheaths. If the laceration occurs in a closed or limited space, the hematoma becomes very tense.

It is important to examine the extremity thoroughly immediately on entrance for the presence, and degree, of peripheral vascular injury so that subsequent examinations will determine whether there is a progression of the pathological changes and the treatment governed accordingly. The first principle in the treatment is the immediate anatomical realinement of the fragments. This may be performed without anesthesia in most cases. A marked displacement can be gently corrected, shock treated, and close observation of the extremity maintained by re-examination at 15 minute intervals.

It is essential to make an early differential diagnosis between a laceration and a thrombosis of the main artery. This can usually be made within a few hours as definite evidence of either clinical picture is manifested early.

In the presence of a laceration of the main artery we believe that an early exploration of the vessel is imperative. If one delays surgery there occurs a sequence of events that may result in death to the patient. The initial traumatic shock, with subsequent diminution of circulating fluids, is supplemented by the loss of blood into the tissues, and if not combatted early a secondary and progressive shock exists from which the patient may not recover. Secondly, as pointed out by Gage (9), the increasing hematoma gradually spreads in the muscle and fascial sheaths, thus causing a rapid ischemia of the tissues and a subsequent gangrene of the extremity. If one is not able to suture the torn or lacerated artery due to technical difficulties, a ligation of the vessel will stop the loss of vital fluid, and also prevent the secondary compression of the collateral circulation. Finally, with the use of heparin and dicoumarin we believe that the secondary arterial thromboses can be prevented in the greater number of cases. This provides the opportunity for a restoration of an adequate circulation distal to the point of interruption by the laceration. Following the arteriorrhaphy the various adjuncts to treatment as discussed below should be instituted. As stated by Matas in acute accidental vascular injuries when ligations are required for the control of hemorrhage, there is little opportunity for vascular exercises to enhance the collateral circulation.

The therapy instituted for a thrombosis of the main vessels is not early surgery, as there is nothing one can accomplish surgically to a vessel that has been traumatized and as a result has a roughened, edematous intimal lining. Rather the therapy should be directed toward the support of the ischemic tissue by enhancing the collateral circulation. An immediate reduction of the fracture tends to reduce the traumatic edema, and also prevents the possible impingement of the malalined fragments on the collateral circulation. The retentive mechanism should be either a traction apparatus, or a posterior molded plaster splint so that one may observe the extremity constantly and also prevent any possible compression of the tissues by a circular cast.

It has been demonstrated by Hainovici (4) that a sudden arterial occlusion produces a marked vasomotor reaction consisting of a spasm in the obliterated segment, in the distal

branches of this segment, in the arterioles, and even in the capillaries. This spasm could extend over to the collateral vessels and make itself manifest in the neighboring vessels even at a distance. Then too, as pointed out by de Takats when a larger artery is suddenly obstructed, the blood pressure below the point of obstruction must fall. This fall has been measured, and, so long as the residual pressure is maintained by the collateral circulation, no secondary thrombosis occurs. The collateral circulation is in turn dependent upon the cardiac output, on the site of the occlusion, and on the state of the collaterals. The only factor that one can control in therapy is the condition of the collateral circulation.

Gage and Ochsner (10) proved that sympathetic block definitely counteracts the pathologic physiology produced by the occlusion of the main artery in the extremity. By doing chemical sympathectomies they were able to produce dilatation of the main peripheral arteries, vasodilatation of the collateral arteries, increase the blood volume flow through the main and collateral arteries, and thus prevent ischemic gangrene.

We believe that an initial chemical lumbar sympathectomy with novocain should be performed as soon as the diagnosis is made. The injections should be repeated, as the effect of the novocain diminishes after several hours. The frequency of injections depends entirely upon the clinical response to the initial and subsequent injections.

It has been felt that heat applied to the extremity and to the abdomen helped in relieving the vasospasm. Freeman, however, in his studies on the effect of temperature in gangrene, found that the more rapid circulation produced by heat in patients with normal blood vessels took care of the increased metabolism produced by the heat, but that in patients with occlusion, the circulation may not be able to develop to the extent required by the increased tissue metabolism. Under such circumstances the discrepancy between the needs and blood supply of the tissues may actually be increased by application of heat.

In a study of the effect of temperature variations on anemic tissue, Brooks and Duncan found definite evidence that diminished temperatures prolonged the viability of the tissue deprived of adequate circulation. However, they stated that further evidence must be obtained before one could definitely state that the period of viability was increased because of an alteration of metabolism in the presence of lowered temperatures.

Therefore, in the early stages of the occlusion, the collateral circulation may be enhanced, and the capillary bed increased by moderate application of heat. Within several hours a maximum effect should have been obtained from the heat, and if the circulation is not restored to near normal at that time, then the extremity should be treated as anemic tissue and an attempt to retard the metabolism by refrigeration should be made.

In addition to the active surgical measures we feel that the vasodilator drugs help to diminish the vasospasm. Atropine sulfate given intravenously immediately, and repeated subcutaneously every 4 hours thereafter is a valuable adjunct in therapy. Copavin given by mouth every 4 hours assists in the vasodilation, and also relieves the pain that may be present. If the pain is severe and persistent, then morphine and pantopon have to be used to keep the patient comfortable.

Finally, in those cases in which therapy fails to re-establish an adequate circulation, amputation should be performed as soon as there is a definite line of demarcation between the normal and gangrenous tissue. If amputation is delayed, the patient becomes toxic with a febrile reaction, general malaise, loss of appetite, and even delirium. A plastic type of flap amputation can be performed if one realizes that the level of ischemic necrosis of the deeper tissues is higher than the line of demarcation seen on the skin. An appreciation of this fact will lower the incidence of secondary amputations.

SUMMARY

1. Four cases of gangrene complicating fractures or fracture-dislocations about the knee have been presented. Dissection of the vessels revealed thrombosis of the main arteries in 2 cases and laceration of the main artery in the other 2 cases.

2. Anatomical dissections demonstrate that vascular complications following fractures about the knee are dependent upon the proximity of the vessels to the bones, and the restraint placed upon these vessels by the surrounding tissue.

3. The therapy for the two different clinical and pathological entities of thrombosis and laceration of the main arteries has been discussed.

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COMPLETE SURGICAL DIVISION OF THE PATENT DUCTUS ARTERIOSUS

A Report of Fourteen Successful Cases

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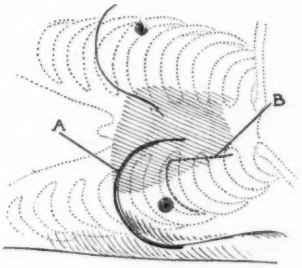
THE ductus arteriosus forms a by-pass which is essential for the circulation during fetal life, but it normally undergoes closure during the neonatal period. If, however, the vessel remains open, the individual is left with a permanent shunt between the aortic arch and the pulmonary artery. Such a communication, if not too large, is compatible with a long and active life, but sufficient evidence has now accumulated to show that patients with this abnormality will frequently develop complications which are of considerable importance. First, the shunt may divert so much blood from the peripheral circulation that the physical growth is retarded, or indeed the mature individual may be stunted. Second, the leak can be of such magnitude that a large volume of blood is passed through it in a useless fashion; hence the work of the heart is greatly increased and the cardiac reserve is reduced, even to the point of circulatory failure. Third, there may be a superimposed Streptococcus viridans endocarditis (or endarteritis of the pulmonary artery). Finally, there are rarer complications such as aneurysmal dilatation of the ductus, rupture of the ductus, and embolism from thrombosis of the ductus. These various hazards are sufficiently serious and appear with great enough frequency to make surgical closure of a patent ductus arteriosus advisable —provided this can be accomplished with a reasonably low mortality rate.

In 1907 Munro suggested that obliteration of a persistent ductus might be performed by surgical means. This was initially attempted by Strieder (1), but for technical reasons the vessel could not be completely shut off and the patient died 4 days later. The first successful ligation of a ductus was reported by Gross and Hubbard (4). In our early cases the restricted size of the operative field and the extremely short length of the ductus led us to simple ligation of the ductus rather than to the more dangerous procedure of dividing it. While the limitations of ligation were obvious, its shortcomings were offset by the fact that it would accomplish the desired result in most instances and that it could be completed with a negligible risk to the individual's life.

Whenever a large artery is obstructed "in continuity" by a single ligature (or closely placed ligatures) tiny crevices may be left as the wall is wrinkled and folded together—hence a small leak remains. If an effort is made to avoid this residual opening by snugging up the ligatures very tightly, there is always the attendant danger of pressure erosion of the vessel wall. Such cutting action can be minimized by employment of broad materials such as linen tape or an aluminum band, but the accumulated experience of many surgeons indicates that this complication cannot be entirely abolished by using any of the substances which have yet been suggested and tried. If such a vessel is cut into (or is cut through) by its ligature, there may be subsequent: (1) re-establishment of the vascular channel, (2) development of a regional hematoma, or (3) fatal hemorrhage. All of these general considerations apply to the surgical closure of any large artery or vein; they are also applicable to the problem of ligation of a patent ductus arteriosus. I have employed simple ligation of a ductus Botalli in 14 patients. Most of these had a perfect or highly gratifying result, but several of them obtained an incomplete closure or else the ligature partially cut through the ductal wall some days or weeks after the operation.

From the Departments of Surgery of the Peter Bent Brigham Hospital, the Children's Hospital, and the Harvard Medical School.

Fig. 1.



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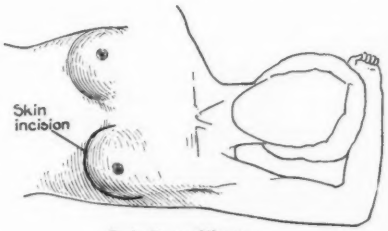

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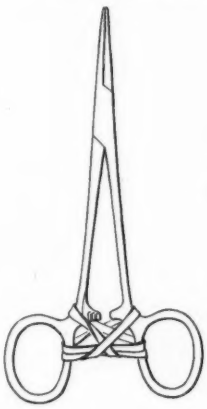

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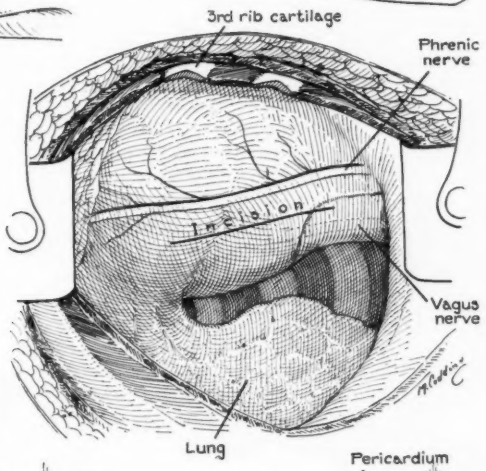

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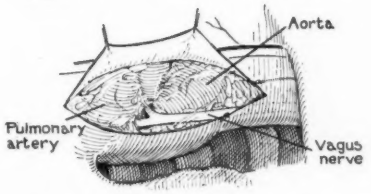

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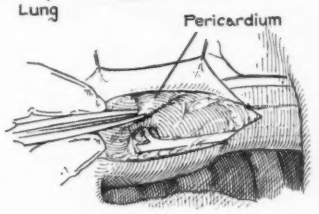


Fig. 1. Position of incisions in relation to heart. *A*. Cutaneous incision. *B*, Cartilage and intercostal incision.
Fig. 2. Cutaneous opening below breast which is subsequently turned upward.
Fig. 3. Method of applying rubber band on the hemostat (the ratchet is never used).
Fig. 4. Chest open. Mediastinum to be opened along black line posterior to the phrenic nerve.
Fig. 5. Flap of parietal pleura held forward with two sutures.
Fig. 6. Lappet of pericardium being raised from ductus (not necessary in all cases).

In order to attain better results than had been secured by simple ligation of a patent ductus, 28 additional patients were operated upon by the following technique. The ductus was compressed with two heavy braided silk ties which were applied with a tension that would not conceivably cut the vessel wall. If the ductus happened to be soft and elastic, this step alone would be sufficient to effect a complete closure; if the ductus was thick, stiff, and unyielding, a small pinhole opening would be left. In either type of case, "unsurfaced" cellophane (about ¼ inch wide and four layers thick) was placed over the silk ligatures and then tied (but not constricting the ductus). As shown by the work of Pearse, there is something in the cellophane which excites a regional fibrosing reaction. The contracting scar tissue compresses the ductus and gradually closes off any small fistula which might have re-

mained at the termination of the operation. In the majority of cases this method (of ligature plus cellophane) gave a complete closure so that no murmur was ever detected after operation; in several patients a small leak was noted after operation which then disappeared in a few months; in 3 patients minimal leaks have persisted for the 1 to 3 year periods since their operations. This technique is undoubtedly an improvement over simple ligation; it carries a very low mortality rate; and it will probably be quite valuable for many additional cases in the future. Its occasional failure fostered the desire to develop a perfect type of undertaking—complete division of the ductus—so that this arteriovenous type of fistula could be immediately, completely, and permanently shut off.

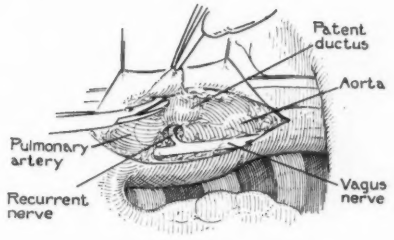
In the presence of an open ductus, the space between the aortic arch and the pulmonary artery is so narrow and the ductus is so short (4 to 6 mm.) that it is usually impossible to place two ligatures on the ductus and cut between these without great danger of having the ligatures slip off and produce fatal hemorrhage. Touroff was able to tie doubly and divide the ductus in 2 patients, but such a technique should be reserved for the rare individual who has an unusually long ductus. After many unsuccessful attempts in the surgical laboratory to devise special clamps and instruments for facilitating a ductal division, these were all discarded and the following procedure was adopted.

The operation herein described has now been used successfully for 14 patients. In each of these it was carried out in a very satisfactory manner. There were often anxious moments about the possible slipping of clamps, the strength of the suture material, or the fear of a sudden and uncontrollable hemorrhage, but the aortic and pulmonary ends of the ductus could always be firmly and accurately closed. It is difficult to predict the percentage of patients for whom complete division can be safely employed. The experience of the operator, the breadth of exposure in the field, the smoothness of the anesthesia, the length of the ductus, etc., are all factors which must be carefully weighed before the attempting of ductal division in any particular instance. If, however, conditions are such that complete division of the vessel can be accomplished, then the surgeon may feel assured that he has performed the best type of correction for this cardiovascular abnormality. Since it has been possible to accomplish a complete ductal division in my last 14 consecutive cases, I am led to believe that only rarely will it be necessary in the future to revert to the less desirable operation of ligation.

OPERATIVE TECHNIQUE FOR DUCTUS DIVISION

Exposure of the superior mediastinum and great vessels has been described at some length in previous communications (2, 3). Hence only a brief summary will be given here regarding opening of the chest and approach to the ductus region. A curved incision is made below the left breast so that the local skin and the entire breast can be turned outward and upward. The pectoral muscles are severed at their attachments to the thorax. The left pleural cavity is entered in the 3d intercostal space; the intercostal muscles should be severed from the sternal border almost to the angle of the ribs. The 3d and 2d costal cartilages are cut so that these ribs can be retracted upward. As the lung collapses away, the heart and superior mediastinum can be viewed from their left lateral aspect. The parietal pleura which covers the mediastinum is opened above the lung root. This incision is carried well up over the aortic arch; it is situated parallel to and midway between the phrenic and vagus nerves. Great care should be taken to identify and isolate the left recurrent laryngeal nerve so that it will not be injured during the subsequent dissection or manipulations. In some individuals lymph nodes will obscure the field and must be dissected away before the underlying structures can be adequately viewed.

Palpation of the great vessels now shows that there is a marked thrill over the pulmonary artery which is widely transmitted to regional structures. The thrill is more intense during systole and tends to die off during diastole. While it can be felt over the entire pulmonary artery, it is most prominent just opposite the opening of the ductus. Not uncommonly the exact position of the ductus is



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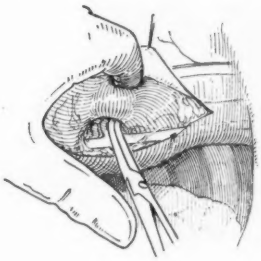

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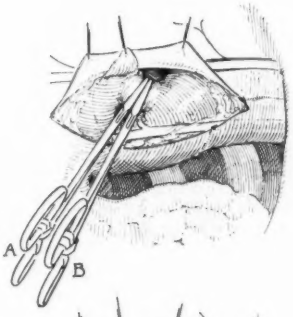

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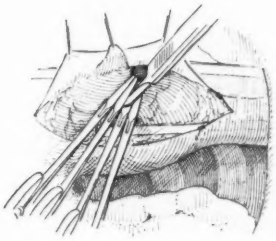

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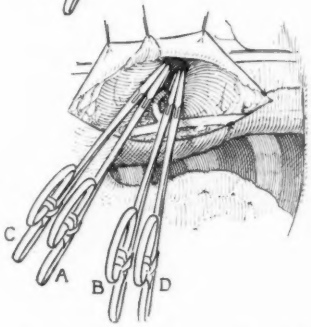

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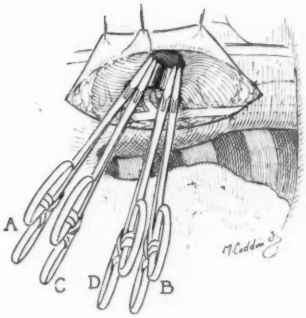


Fig. 12.

Fig. 7. Lappet of pericardium being dissected off of ductus and pulled forward.
Fig. 8. Ductus being bluntly freed around its entire periphery.
Fig. 9. Two clamps on ductus (held in place only by tension of rubber bands on the handles).
Fig. 10. Four clamps applied. Ductus being cut with scalpel between two middle clamps.
Fig. 11. Ductus divided. Two clamps remain on either end of the vessel. To obtain more length of vessel to work upon, Clamp *A* will be shifted *proximal* to *C* and Clamp *B* will be shifted *proximal* to *D*.
Fig. 12. Clamps shifted.

at first obscure because overlying fat and areolar tissue cover over and hide it. Under such circumstances, a finger-tip can be pushed posteromedially into various parts of the groove between the aortic arch and pulmonary artery. If steady and firm pressure does not change the regional thrill. the finger is then moved to another part of the groove and pressure is reapplied. This topical examination is repeated in different areas until a point is found where the pressure will compress the underlying ductus and thereby abolish the thrill in the pulmonary artery. Finding the ductus can also be facilitated by tracing the recurrent laryngeal nerve downward, since this passes lateral and then posterior to the ductus.

After the ductus has been identified, the fat is slowly and carefully cleared from its anterior and lateral surfaces. The anteromedial part of the dissection can usually be accomplished by delicately placing the point of a half-length clamp between the aortic arch and the pulmonary artery and gently spreading the jaws apart. The instrument is then passed deeper into the slit thus made and the tissues are further bluntly dissected. Occasionally there is a rather fibrous web stretching between the pulmonary artery and the medial surface of the aortic arch, the fibers of which are best severed with small-bladed scissors. The medial border of the ductus deserves the utmost care; it can be bluntly separated from the underlying left main bronchus by a right-angle clamp. Very delicate dissection must be employed since this medial wall may be thinner than one anticipates. If the vessel is accidentally torn, exsanguinating hemorrhage can occur with alarming rapidity. (In only 1 of 56 surgically treated cases of our series has there been any bleeding from the ductus wall. While there was an immediate and serious loss of blood, the rent could be closed and the patient survived.) The literature contains several reports of rupture of a ductus during operation, giving rise to fatal hemorrhage on the table. Consequently one should be exceedingly slow and cautious and gentle while dissecting the vessel away from the surrounding structures.

In some subjects the pericardium has a very high reflection and a pannus of it overlies the ductus. This flap of pericardium should be freed from the ductus and the adjacent pulmonary artery by sharp and blunt dissection so that it can be turned forward out of the way. Every effort should be made to keep the pericardial envelope intact, because an opening in it allows continual escape of frothy fluid which runs down on the operative field.

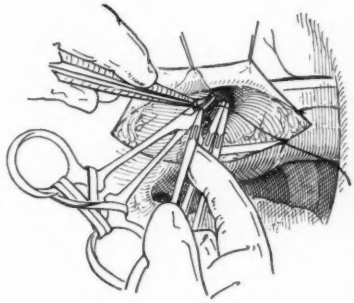
The ductus must have more than a narrow zone of clearing around its periphery; it should be widely freed from structures which lie against its posterior and medial surfaces. Subsequent steps will demand considerable mobility of the medial ductal wall as well as the adjacent medial surfaces of the aortic arch and pulmonary artery. Hence, it is imperative that these places be cleared as much as possible before the surgeon attempts actual division of the ductus.

Two clamps are now placed directly on the ductus as shown in Figure 9. It has been found that standard straight hemostats about 5½ inches in length will have jaws of optimum size. (The base of the jaws should be ground off on both sides so that these surfaces will be nearly parallel.) It is important to employ clamps which are either new or which have been well cared for, so that no undue wiggling or side motion occurs at the hinge which would allow side-play of the jaws. A clamp should never be closed so that the handle ratchet becomes engaged, since this amount of pressure will produce crushing injury to the ductal wall and will probably lead to subsequent sloughing. It has been satisfactory to place a new rubber band around the handle as shown in Figure 3, so that the instrument is held in place solely by the tension of this rubber band.[1] The elastic band can be made sufficiently taut so that the clamp will not slip off the ductus wall and yet it will not have sufficient pressure to crush the vessel.

When two clamps are applied (Fig. 9), they appear to take up all of the available room between the aortic arch and the pulmonary artery. However, it is now possible to squeeze in an additional clamp on the aortic side and another one on the pulmonary side so that four clamps are in position (Fig. 10). The outside clamps will be found to ride up on the pulmonary artery and aorta, respectively. With a small scalpel, the ductus is now divided between the two middle clamps, so that two instruments remain on the pulmonary end and two on the aortic end of the ductus (Fig. 11). All of these clamps must be left free in the field so that they can slide with the respiratory motions of the mediastinum and with the beating of the great vessels. They must not be allowed to flop downward nor should they become impinged against the chest wall. They must not be struck by the operator's or assistant's hands. Any such pressure, angulation, or jarring of the clamps may dislodge them from the ductus.

[1]It is possible that clamps could be applied and the ratchets closed without causing crushing injury of any importance. However, I have always chosen to avoid this danger by using the elastic bands on the clamp handles.

Fig. 13.



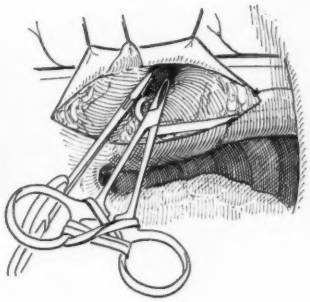


Fig. 15.

Fig. 14.

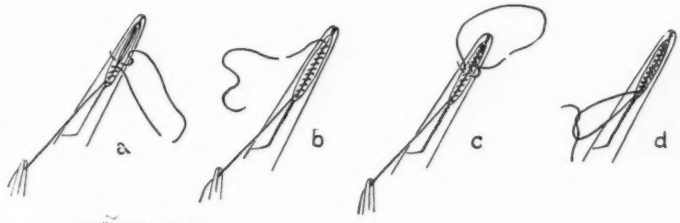
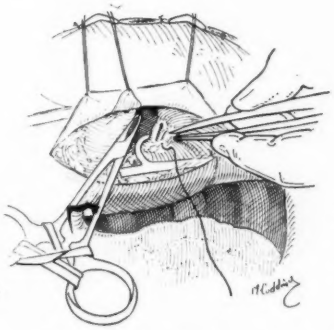


Fig. 16.



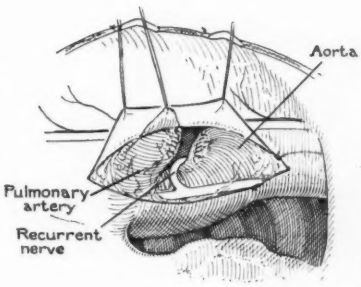


Fig. 17.

Fig. 13. Distal clamp removed from pulmonic end. Single clamp remains for hemostasis. Beginning suture of the presenting cuff (formed by removal of distal clamp).

Fig. 14. Details of cuff suture. a, Continuous fine silk suture. b, Row of suture completed. c, Suture continued back—making an overlacing closure. d, Suture being tied.

Fig. 15. Distal clamp has been removed from aortic end (the cuff will be treated as in 14 a-d).

Fig. 16. Hemostatic (proximal) clamp taken off of aortic end. Second row of sutures being started to bring together adventitia (over the first suture line).

Fig. 17. Remaining clamp off of pulmonic end, and adventitial suture completed. (This gives two rows of suture on aortic end and two on the pulmonary end.)

The recurrent laryngeal nerve must be kept constantly in mind and protected from injury by the hemostats or sutures. It can be freed readily from its bed and can be displaced downward away from the ductus for 4 or 5 millimeters. When the hemostats are placed on the ductus, their tips must not catch the inferior cardiac nerve which arises from the recurrent laryngeal nerve. Furthermore, the jaws of the hemostats must be placed on the ductus in such a way that they cannot back off; on the other hand they must not protrude so far inward that they pierce the underlying left main bronchus.

After the ductus has been severed, the distal clamp on the pulmonary end is removed. This leaves a small 2 or 3 millimeter cuff which can be sewed over and over with a continuous fine silk stitch. If by any chance the removal of the distal clamp leaves too short a cuff, additional length of the cuff can be obtained by putting a clamp proximal to the remaining clamp, and then removing this latter (Figs. 11 and 12). After 10 to 15 bites are taken in the ductal end (Fig. 14), the stitch is then run back over the cuff so as to make a basket-like or interlacing closure. It is highly important to use fine silk which is waxed or oiled so that it will slip easily through the vessel wall without tearing it. Deknatel No. ooooo (size B) has a high tensile strength combined with a small diameter which makes it a superb material for this delicate task. It must be mounted on an atraumatic needle. In all of the present cases a small, curved, non-cutting (Deknatel eyeless needle No. 9) needle was found to be perfect for the job.

The aortic end of the ductus is now treated. The distal clamp is removed, the proximal one being left for hemostasis, and the cuff of tissue is whipped over and over as previously described for the pulmonic end. It will be found that if the pulmonary end has been treated first—and hence one of its clamps is out of the way—more room will be obtained to facilitate work on the aortic side, where it is highly important to have a tight and accurate closure.

After the first row of aortic sutures has been placed, the single remaining clamp is slowly removed. If the first line of sutures has been properly taken, there will be no bleeding. If, however, some oozing does occur, a sponge should be pressed directly over the line of suture for 3 or 4 minutes until clotting occurs. When the field is dry, a second suture line (Fig. 16) is made, the adventitia being brought together with a continuous fine silk suture to cover and support the first row of stitches.

Finally, the remaining clamp is removed from the pulmonary end of the ductus and a second layer of continuous sutures is placed in order to bring together its adventitial structures. These steps have now produced a double closure of the aortic and of the pulmonary sides of the ductus. (In the last 8 cases here reported, great care was used in the placing of the first layer of sutures on the pulmonary artery and the aorta; the second layers of sutures were omitted. The results have been completely satisfactory.)

The mediastinum is covered by the bringing together of the edges of its parietal pleura with interrupted silk sutures. Repair of the bony cage and the overlying wound can be accomplished rapidly, but if time is spent in a meticulous closure, the patient will have a smoother and more satisfactory postoperative course. A rather stiff rubber urethral catheter (No. 16 or 18 French), with several holes cut in its tip, is led down into the posterior portion of the pleural cavity and is brought out through the chest wound. The ends of the 2d and 3d costal cartilages are now repaired with ligatures, preferably of silk, so that any delay in the healing of the cartilages will not allow the ends to override. The 3d and 4th ribs are brought together with 4 or 5 encircling, heavy, chromic catgut sutures. The intercostal muscles are approximated with a continuous chromic catgut suture. The pectoral muscles are sewed down to the chest wall, and the anterior pectoral fascia is repaired with interrupted sutures, preferably of fine silk. The superficial fascia is brought together and then the subcutaneous fat is closed with several layers of fine sutures. In order to obtain a hair-line cutaneous scar—which will not subsequently spread—the corium must be accurately approximated and no fat must be allowed to protrude up between its edges. This is best accomplished with interrupted, fine, white silk stitches. Finally, the epidermis is brought together with a continuous corium suture of "dermic"; this latter is left in place from 8 to 12 days before removal. This gives an admirable skin closure which leaves no stitch marks.

Just before the skin is brought together, suction is applied to the catheter which had been previously placed in the chest. In this way all the air is withdrawn, and the catheter is then pulled out. Expansion of the lung in this way causes less postoperative reaction than does expansion of it by a high positive pressure through the anesthesia machine.

REPORT OF CASES

The technique which has been set forth in the preceding section has now been used on 14 human subjects. These varied in age from 3 to 24 years. There have been no fatalities or important complications. The postoperative hospitalization has averaged 15 days; the earlier patients were kept a longer period because of interest in their courses, but more recently the individuals have been discharged on the 8th or 9th day. Two patients had a superimposed subacute bacterial endocarditis (Streptococcus viridans) prior to operation. Division of the ductus in these cases was done with considerable trepidation, for fear that infection in the ductal wall would allow the sutures to slough out and lead to fatal hemorrhage. However, these operations were completed without any more difficulty than was encountered in the uninfected cases.

SUMMARY

Ligation of a patent ductus arteriosus has produced satisfactory closure in most of the 14 cases in which it was used as the only method of obliterating the shunt. Better results were obtained in another series of 28 patients in whom the ductus was ligated and was also wrapped with cellophane to promote regional fibrosis. While this latter method has been an improvement over the earlier procedure, it has failed in a few instances to produce absolute stoppage of the fistula. A new technique is now presented for complete division of the ductus which insures prompt and complete closure of this vessel. It has been performed in 14 patients, 2 of whom had a superimposed Streptococcus viridans endocarditis. All the patients have recovered and none has had any important complication from the operative undertaking.

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THE IMPORTANCE OF FOCAL INFECTION IN OBSTETRICS

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AFTER an acute local inflammation has subsided, the bacteria that caused it frequently persist in the local tissues, where they either remain inactive or produce a chronic local inflammation of a latent, mild, or moderate character, depending upon the degree of local resistance in the infected tissues. Whether the infecting germs in a chronic local infection confine their activities to the tissues they inhabit or whether they or their soluble toxins are carried by the blood stream to other tissues, more or less distant, depends to a great extent upon the general resistance of the patient. When bodily resistance is high, foci of infection may exist for years without producing disease elsewhere. Lowered general resistance, however, enables the infecting organism in a primary focus of infection to form metastases or secondary foci of infection outside of the tissues in that focus. This is known as focal infection. Among the factors that lower general resistance are fatigue, unhygienic living, acute and chronic illnesses, chilling, hemorrhage, pregnancy, and trauma—including the trauma of childbirth and of operations.

A number of obstetricians conclude from clinical observation that many of the accidents, diseases, and complications of pregnancy are the result of focal infection. They consequently emphasize the importance of removing all foci of infection that are accessible and removable. Most obstetricians, in my opinion, direct their attention chiefly to the oral cavity and ignore to a great extent infection in the upper respiratory tract.

The various conditions that obstetricians believe can be caused by focal infection will be considered separately.

Abortion. Bland and First, La Vake (24), Mosher, Pierrepont, Schumann, and Talbot (44) recognize focal infection as one of the causes of abortion. Talbot (44) explains the process as the result of hematogenous infection of the maternal blood vessels of the placental site by bacterial emboli from a focus of infection. The process of infarct formation, he shows, destroys the function of just as much of the placental tissue as is involved by the thrombotic process. Thus a portion of the feeding surface for the fetus is taken away. In the early months of pregnancy when the total placental area is small, the infarcted area may be relatively large. When this proportion is large enough it results in the termination of the life of the fetus, which in turn results later in miscarriage, or the throwing off of the dead fetus. This explains the greater incidence of miscarriage within the first 3 months of pregnancy.

The toxemias of pregnancy. Focal infection is regarded as one of the causes of the toxemias of pregnancy by Adair, Bland and First, De Lee, Evers, Fowler, La Vake (24), Mosher, Pierrepont, Reed and Cooley, and Talbot (45). The last named has presented considerable evidence, both experimental and clinical, showing that toxemia of pregnancy is primarily due to bacterial invasion of the organs of the pregnant woman from foci of chronic infection. De Lee stated that focal infection may be the underlying cause of a gestosis and that removal of foci of infection has sometimes worked a cure.

Mackenty observed that obstetricians are inclining to the belief, backed by considerable clinical evidence, that the toxic vomiting of pregnancy is in some way related, directly or indirectly, to toxic focal disease. The association of the pernicious vomiting of pregnancy with foci of infection has been referred to by Bland and First, Evers, Reed and Cooley and Talbot (46).

Eclampsia and pre-eclamptic toxemia are believed by Adair, Mosher, Pierrepont, and Talbot (47) to be due to focal infection.

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Mackenty quoted the statement, made to him by an obstetrician whose experience has been unusually large, that since medicine and surgery had been active in the elimination of toxic foci, eclampsia has been greatly reduced.

The nephritis of pregnancy. The part played by focal infection in the etiology of nephritis associated with pregnancy is mentioned by Alport, Bland and First, Evers, Mosher, Randall, Stieglitz, and Talbot (45).

Pyelitis during pregnancy. Many authors, according to Kretschmer, consider that a focus of infection is important in the causation of the pyelitis of pregnancy. Bland and First, Danforth, Randall, Reed and Cooley, and Talbot (44, 46) likewise direct attention to focal infection as an etiological factor.

Disorders of the placenta. Young believed that premature separation of the placenta is in many instances due to a thrombosis of the uterine and ovarian vessels, causing a hemorrhage and a separation of the placenta from the damming back of blood. La Vake (24) goes a step further and postulates infection or bacterial toxins as a possible source of the thrombosis, giving evidence of severe accidental hemorrhage being due to focal infection. He believes that the clearing up of all foci of infection in pregnant women, as far as it is possible or expedient, may aid in reducing the incidence of accidental hemorrhage.

Talbot (45) is convinced that many placental infarcts are due to hematogenous infection of the maternal vessels of the placental site. He has observed more than 50 cases in which a bleeding spell was recorded upon the placenta by contemporaneous white infarction on its edge or by cessation of growth. Many of these attacks of bleeding were associated with demonstrable acute infection in the mouth and throat. Talbot's clinical observations suggest that the acute infection causes the bleeding from the placental site, and that the white infarct on the edge of the placenta is the result of this pathological lesion. It seems to him justified to make the deduction from clinical and laboratory evidence that many placental infarcts are evidence of blood-borne infection from the point of entrance in the head to the uterine tissues immediately beneath the placenta (45).

The infarcted area in the early months of pregnancy may occur in the middle of the placenta or on its edge. When on its edge, the damage done prevents the further enlargement of the placenta at that point. When the concentric enlargement of the placenta is thus inhibited, there is the compensatory growth on the undamaged edge of the placenta to supply the needs of the growing fetus. This results in the assymetrical type of placenta (44). When the original attachment of the ovum is low enough in the uterus, an infarct in the early months of pregnancy may drive the compensating growth of the placenta downward, with the result that low-attached placentas, marginal and complete placenta praevias may result (47). Talbot (44) says that a certain proportion of this class of placenta previa are preventable by removing known foci of chronic sepsis before they do harm. Infection of the whole edge of the placental site he believes may be the determining factor in the so called placenta circumvallata or its modifications.

In the experience of Bland and First and of Mosher, foci of infection may predispose to premature separation of the placenta.

Puerperal sepsis. The old idea in regard to puerperal sepsis was that the infecting germs are introduced by the finger or instrument of the obstetrician or through contact of the vulva with unclean hands, linen, or other objects.

Of the avenues of internal infection, one is the presence in the birth canal prior to labor of a streptococcus which is able to infect when the patient's general resistance is lowered by the shock, hemorrhage, exhaustion, and fatigue of delivery and when the local resistance of the birth canal is lowered by the trauma produced.

Another avenue of internal infection is the direct transmission to the uterus of bacteria from the respiratory tract of an individual attending the confinement.

A third cause of puerperal sepsis of internal origin—one insufficiently recognized by the profession at large—is focal infection.

As long as 40 years ago Ahlfeld called attention to the fact that a woman occasionally becomes infected from bacteria which are transported to the genital canal via the blood

stream from a distant site of suppuration, such as infected tonsils, lungs, or breast. De Lee likewise refers to the inoculation of the patient by herself with bacteria carried from a focus of suppuration. It is undoubtedly true, according to Schumann, that a definite proportion of cases of puerperal sepsis is traceable to an autogenous infection. Beck, Bland and First, D. Colebrook, Condon, Evers, Irving, Lancefield and Hare, Lash, La Vake (24), Ramsey and Pierce, Rose, White et al., and Woodward and Gardner concurred.

Breast abscess. Talbot (44, 46) regards breast abscess as an infection of hematogenous origin and a manifestation of chronic sepsis.

Among the etiological factors concerned with the development of breast abscess, Dippel and Johnston likewise cite foci of infection. They say that the association of breast abscesses with infection elsewhere in the body, such as the uterus, urinary tract, tooth, finger, or upper respiratory tract, occurs and culturally shows the same organisms too often to be merely coincidental. Harris reported a case in which the breast milk and dental foci contained the same organism and in which the infection in the milk cleared up on the removal of the infected teeth. He also described a case of breast abscess of 2 years' duration, which healed in 2 weeks after dental infections were removed.

Phlebitis. Chronic sepsis is regarded by Talbot (44) as the etiological factor in phlebitis. La Vake's (25) experience has indicated to him that dental infection, concealed or open, means an increased chance of postpartum phlebitis.

The removal of foci of infection. At no time should operation upon a focus of infection be regarded lightly, irrespective of pregnancy. The operative trauma, by lowering bodily resistance, may even produce a spread of the infection. Such simple procedures as tonsillectomy and dental extraction have precipitated disease of the heart, kidneys, joints, and eyes.

It is possible, however, to minimize the dangers of such an operation by the exercise of extreme gentleness, by not removing more than one tooth at a sitting, by preparing a patient prior to operation with a view to raising her resistance, by attention to postoperative care, by preoperative autogenous vaccinotherapy, and by administering a sulfonamide for 3 days before and 3 days after operation.

In attempting to rid a patient of infected tissue one must remove all such tissue. Infected tonsillar remnants and broken-off infected tooth apices are as dangerous as diseased tonsils and abscessed teeth. Moreover, secondary foci should not be neglected; for they can keep up the focal infection.

Operations on a focus of infection during pregnancy. It is the general opinion, according to Bland and First, that there is no danger associated with oral surgical therapy, including extractions, during pregnancy, except in a very limited number of women who exhibit a tendency to miscarry. In Ziskins' experience, the removal of dental foci caused no increase in the number of miscarriages, abortions, or stillbirths. From his records of the dental operations on 720 pregnant women he concludes that dental treatment for pregnant women may be approached with no more hesitation than for other types of patients and that dental operations may be performed without ill effects during any month of pregnancy.

La Vake (25) says that obstetrically it is more safe to eradicate at once all definite foci of infection than to wait. He believes that pregnant women stand all anesthetics well, subject to the individual idiosyncrasies of the nonpregnant, and that they stand operation well so long as the infection does not supervene or a cause of high temperature does not operate. In eradicating foci of infection he warns that we must drain with care to avoid, if possible, severe vaccination reaction.

Bubis also believes that less harm will be done by treating these foci during pregnancy than may occur if they are neglected until after childbirth.

Talbot (48), however, thinks it is not safe to take a chance on increasing the activity of sepsis before the beginning of the fourth month. He likewise believes that chronic sepsis should not be disturbed in the presence of toxemia of pregnancy. He regards the safest time to be between the fourth and seventh months of pregnancy. He prefers, however, to remove foci of chronic infection either before or between pregnancies.

Neglect of the purely bacterial focus of infection. Obstetricians share with otolaryngologists and most physicians a serious misconception of a focus of infection (34), doubtless due to Billings' definition of it as "a circumscribed area of tissue infected with pathogenic organisms." I would stress the infecting *organisms*, rather than the infected *tissue*, and would define a focus of infection as "infecting bacteria, pathogenic for their host and producing toxins inimicable to him, which have their habitat in a more or less circumscribed area." Thus defined, a focus of infection in the upper respiratory tract is never removed by the surgeon's knife, which merely extirpates infected tissue and drains infected cavities. After a tonsillectomy, for instance, the infecting bacteria may still be found in the tonsillar fossae, in the nasopharynx, and on the faucial pillars and adjacent tissues, and, after sinus drainage, in the sinus, nares, and nasopharynx, where they remain and multiply and elaborate toxins, until they are overcome by the patient's defensive forces (35, 36, 37). Their destruction, however, may follow the operation spontaneously, especially when attention is given to hygienic measures. In most cases, however, the writer has found it necessary to stimulate antibody production artificially by administering a potent autogenous vaccine (37, 38, 39), made from pathogen-selective cultures (10, 40, 41, 42), which are those most likely to contain the infecting germ. As this vaccine is very potent, it must be given extremely carefully in the appropriate dosage for the individual patient (38). Bernstine and his associates (5, 6, 7), however, have reported favorable results from stock vaccine.

The disappointing results experienced by most obstetricians in prophylactic immunization are due, in my opinion, to failure to discover, treat, and culture all foci of infection, failure to include the infecting organism and its soluble exotoxins in the vaccine, and failure to administer the vaccine properly.

SUMMARY

Focal infection is a frequent cause of many of the accidents, diseases, and complications of pregnancy, labor, and the puerperium.

Great caution should be observed in removing infected tissue at a focus of infection at all times and especially during pregnancy.

Removal of infected tissue at a focus of infection frequently fails to eradicate the infecting organisms, which may continue to multiply and to elaborate toxins and thus keep up the focal infection.

The elimination of these microbes may require artificial stimulation of antibody production by the careful administration of a potent vaccine containing the infecting bacteria and their soluble exotoxins.

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NUTRITIONAL DEFICIENCY IN THE ETIOLOGY OF MENORRHAGIA, METRORRHAGIA, CYSTIC MASTITIS, AND PREMENSTRUAL TENSION

II. Further Observations on Treatment with the Vitamin B Complex

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OBSERVATIONS made 2 years ago that the liver loses its ability to inactivate estrogen in vitamin B complex deficiency led us to investigate the relation of nutritional deficiency to clinical syndromes associated with excess estrogen.

When a pellet of estrone or estradiol is implanted in the spleen of a castrate female rat, the absorbed estrogen must pass first through the liver via the portal circulation (3, 4). On a complete diet such an animal remains anestrous; on a vitamin B complex free diet it goes into continuous estrus (6). Brewer's yeast restores the anestrous state; subsequent depletion again leads to estrus (7). The flow of estrogen through the liver can be controlled at will, by withholding the B vitamins or by restoring them to the diet. The same phenomenon occurs if, instead of implanting a pellet, one ovary is transplanted to the spleen and the other is removed (9). It occurs in the absence of detectable gross or histological lesions in the liver (7).

When, however, pellets of testosterone propionate are implanted in the spleens of castrate male rats, there is no significant difference in the weights of prostates and seminal vesicles in animals on a B free or in those on a yeast supplemented diet (8). Estrogen ceases to be inactivated in vitamin B complex deficiency while androgen continues to be inactivated; thus a serious alteration must occur in the estrogen-androgen equilibrium.

We undertook to find out whether patients with signs and symptoms of nutritional deficiency had menorrhagia, metrorrhagia, painful breasts, premenstrual tension, or a combination of these. And patients who presented one or more of these conditions were investigated as to their nutritional status. A striking correlation was found, and treatment with vitamin B complex was instituted.

Preliminary observations previously reported on 29 patients (5) have now been extended to include studies on 104 patients, of whom 70 were treated with various preparations of vitamin B complex.

Lest it be assumed that the phenomena related to nutritional deficiency to be described are characteristic only of clinic patients in certain localities, it should be pointed out that more than half the treated patients were private ones living in New York, Ohio, California, and Oregon. These observations were made by the 3 of us, each working independently in a different city.

Of 39 patients who were observed primarily because of the presence of lesions of nutritional deficiency, 37 had a history of menorrhagia, metrorrhagia, painful breasts, premenstrual tension, or a combination of these. Of 52 patients whose main complaint was one of the latter conditions, and who were examined for evidences of nutritional deficiency, every one had signs or symptoms or both, characteristic of B avitaminosis, and these signs and symptoms improved on vitamin B therapy concomitant with improvement in the gynecological complaint. Glossitis and cheilosis were common but not always present.

The response to vitamin B complex therapy in these patients was usually prompt and often dramatic. Some of the patients showed only moderate improvement on oral therapy; as impairment of absorption and utilization occurs frequently in nutritional deficiency, these patients were given parenteral therapy in addition. With the latter, striking improvement, especially in premenstrual tension and in painful breasts, often occurred in as little as a few hours to at most a day or two.

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TABLE I.—SUMMARY OF CLINICAL FINDINGS AND RESULTS OF TREATMENT WITH VITAMIN B COMPLEX IN MENORRHAGIA, METRORRHAGIA, CYSTIC MASTITIS, AND PREMENSTRUAL TENSION*

No. Patient Age	Gynecologic and associated disorders	Duration	Major indications of nutritional deficiency	Treatment	Duration	Result	Comment
1 R.G. 46	Menorrhagia; flow 9 days	5 yr.	Glossitis	Oral B complex	3 mo.	Glossitis healed; subsequent periods 3, 6 and 3 days, normal flow	
2 M.G. 42	Menorrhagia; flow 4–10 days; premenstrual tension	4 yr.	Glossitis; cheilosis; stomatitis; intertrigo	Oral and parenteral B complex	11 mo.	All signs of B deficiency healed except faint trace of cheilosis. 11 normal periods, mainly 3–4 days. Premenstrual tension cleared up on parenteral therapy	Intertrigo had long resisted dermatologic therapy, healed promptly on B complex. Goiter diminished strikingly in size
3 R.B. 30	Alternating menorrhagia and amenorrhea	6 yr.	Glossitis	Oral B complex	10 wk.	Glossitis healed; 2 normal periods 6 and 5 days' duration	
4 M.W. 15	Metrorrhagia; enlarged uterus	4 mo.	Lingual edema; peripheral neuritis	Oral B complex	9½ mo.	No metrorrhagia after 1 wk. of therapy except for slight spotting 2–5 days midcycle only; 9 successive normal periods, 2–5 days' duration	Re-examination under anesthesia after 5 mo. of therapy showed uterus of normal size. Lingual edema cleared; peripheral neuritis improved slowly
5 F.H. 39	Menorrhagia; flow 6–7 days; premenstrual tension and painful breasts	many yr.	Severe glossitis; skin lesions; clouding of consciousness; impairment of memory; extreme fatigue, etc.	Oral and parenteral B complex	7 mo.	6 successive normal periods 3 days' duration; premenstrual tension and breast tenderness subsided; avitaminotic lesions healed; mental symptoms much improved	Moderate improvement on oral therapy; striking improvement on combined oral and parenteral therapy; recurrence of cutaneous lesions and premenstrual tension on stopping parenteral therapy
6 S.R. 35	Severe cystic mastitis with recurrent infection left breast and high fever; severe premenstrual tension	5 yr.	Recurrent cheilosis	Oral and parenteral B complex	14 mo.	Striking subsidence of premenstrual tension and improvement in general health; only 3 mild attacks of infectious mastitis in 14 mo. (previously these occurred almost monthly)	Syndrome associated with psoriasis and arthritis; improvement occurred in these also. Nodular quality of breasts subsided on oral therapy; residual tenderness disappeared first time in 5 yr. after daily parenteral therapy
7 P.W. 36	Menorrhagia; cystic mastitis; premenstrual tension; uterine myoma	More than 10 yr.	Mild glossitis; recurrent cheilosis; premenstrual acne	Oral and parenteral B complex	10 mo.	Complete regression of cystic mastitis and subsidence of premenstrual tension. Periods formerly 4–5 days now last 3 days	Avitaminosis B associated with chronic enteritis. Premenstrual acne cleared up under B complex therapy. Diminution in deposition of fat over thighs, hips, and abdomen without loss in weight
8 N.O. 40	Menorrhagia; flow 10–13 days	6 yr.	Glossitis	Oral and parenteral B complex	12 mo.	Progressive reduction in amount of menstrual flow; periods now last 4 days, normal flow. Striking improvement in general health	Maintained on oral B complex alone for 5 mo.; recurrence of menorrhagia on stopping oral therapy normal period after resuming oral B complex
9 R.H. 31	Menorrhagia; flow 12–15 days	18 mo.		Oral and parenteral B complex	5 mo.	Progressive reduction in duration of periods to 9, 9, 7, 8 and 5 days respectively	Preliminary exacerbation of dysmenorrhea under therapy; this later subsided
10 S.B. 22	Cystic mastitis; premenstrual tension	6 yr.		Oral and parenteral B complex	4 mo	Little or no breast tenderness, no premenstrual tension in 3 periods	Following B complex therapy, menstrual flow appeared without usual premonitory symptoms

*Footnote on page following table.

TABLE I.—SUMMARY OF CLINICAL FINDINGS AND RESULTS OF TREATMENT WITH VITAMIN B COMPLEX IN MENORRHAGIA,

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*Footnote on page following table.

TABLE I.—SUMMARY OF CLINICAL FINDINGS AND RESULTS OF TREATMENT WITH VITAMIN B COMPLEX IN MENORRHAGIA, METRORRHAGIA, CYSTIC MASTITIS, AND PREMENSTRUAL TENSION—Continued

No. Patient Age	Gynecologic and associated disorders	Duration	Major indications of nutritional deficiency	Treatment	Duration	Result	Comment
11 R.P. 26	Premenstrual tension; cystic mastitis	2 yr.	Glossitis; cheilosis	Oral B complex Oral and parenteral B complex	5 mo. 2 mo.	Moderate improvement in tension and breast tenderness Complete regression of mastitis; no premenstrual tension in 2 periods	Glossitis and cheilosis healed; previously susceptible to sunburn—tanned first time in her memory after oral B complex Loss of 2 in. in circumference of bust and 1½ in. in hips; weight stationary at 212 lb.
12 M.W. 15½	Menometrorrhagia since menarche	4½ yr.	Lingual edema; severe gingivitis; seborrhea alae nasi	Oral B complex	4 mo.	4 successive normal periods 4–5 days duration; no intermenstrual spotting	Facial acne present since menarche—premenstrual exacerbations; previous dietary therapy for acne further deteriorated nutritional status; acne almost completely cleared up on B complex; avitaminotic lesions healed rapidly
13 A.S. 35	Menorrhagia; severe premenstrual tension; painful breasts	Many yr.	Mild glossitis and cheilosis; seborrhea alae nasi; fatigue; insomnia; clouding of consciousness; cutaneous hyperesthesia	Oral and parenteral B complex	6 mo.	Diminution in menstrual flow; subsequent periods 6, 5, 4, 3, 3, 3, days' duration; complete subsidence of premenstrual tension and breast tenderness	Striking decrease in fat deposition about hips, thighs, and abdomen before any loss in weight occurred; cutaneous hyperesthesia disappeared; marked improvement in tolerance for and response to thyroid; maintained subsequently on oral B complex alone
14 M.G. 34	Cystic mastitis; "cystic fibroma" right breast; premenstrual tension	More than 10 yr.	Mild glossitis and cheilosis; recurrent vesicles oral mucous membrane; seborrhea alae nasi; cutaneous hyperesthesia; fatigue, etc.	Oral and parenteral B complex	5 mo.	Striking improvement in avitaminotic lesions and symptoms; no breast tenderness or premenstrual tension in 5 successive periods	Complete regression of mass 3 by 3 by 1 cm. in right breast in 3 mos. Maintained subsequently on oral B complex alone
15 D.S. 47	Severe premenstrual tension; 2 previous episodes of menorrhagia	Indefinite	Glossitis; insomnia; impairment of memory for recent events; extreme irritability; pain in legs	Oral B complex Oral and parenteral B complex	6 wk. 3½ mo.	No improvement Rapid and complete subsidence of all symptoms	Marked relief of persistent pain in legs of many yrs.' duration, refractory to other therapy
16 N.S. 25	Premenstrual tension; dysmenorrhea	Few yr.	None except extreme fatigability; premenstrual acne	Oral B complex	3 mo.	Marked improvement in general health; no premenstrual tension or dysmenorrhea in 3 successive periods	Premenstrual acne did not recur under B complex therapy
17 L.M. 28	Profuse menorrhagia; premenstrual tension and breast tenderness	3 yr.	Lingual edema	Oral B complex	6 mo.	Diminution in menstrual flow; subsequent periods 5, 4, 3, 3, 3, 3, days' duration; no premenstrual tension or breast tenderness	Premenstrual blepharoconjunctivitis since menarche at 12 except during pregnancy 3 yr. before starting B therapy; repeated subsidence of eye condition under sulfathiazole with invariable recurrence; no recurrence following local sulfathiazole while on B complex
18 J.H. 13½	Menometrorrhagia since menarche; periods every 21 days, duration 9–10 days	6 mo.	Severe glossitis; gingivitis; recurrent vesicles oral mucous membrane	Oral B complex and additional niacin amide	3 mo.	No intermenstrual bleeding after 3 wk. of therapy; 3 periods 7, 6, and 5 days' duration; interval increased to 27 days	Glossitis showed initial striking improvement but was still present 11 wk. later; other lesions cleared up completely

CASE REPORTS

Of 29 cases previously reported, 7 were presented in detail. Five of these 7 are still under observation. The pertinent data on all seven cases are recapitulated in Table I together with observations subsequently made. An additional 11 cases are presented in Table I in considerable detail. Owing to space restrictions, only 50 of the total of 104 cases are included in the tabulations; of these, 32 are presented more briefly in Table II. Four cases have been chosen for more extended exposition; they are numbered as in Table I.

CASE 8. N. O., aged 40 years, since her last pregnancy 6 years previously, had had menorrhagia lasting from 10 to 13 days; this confined the patient to bed for the first 2 days of each period and required the use of as many as 40 large double pads per period. During the 6 years several curettages had been done, none of which had any effect on the menstrual flow. The last curettage was in September, 1942; the endometrium showed cystic hyperplasia. This patient had an atrophic glossitis. She received oral and, later, oral and parenteral vitamin B complex therapy. The first subsequent period after a month of therapy lasted 4 days, required 18 pads; the next 4 periods were of the same duration and required 12 pads for the first and 9 each for the remaining 3 periods. Accompanying the improvement in the menstrual flow, there was striking improvement in physical well-being, as well as healing of the glossitis. For 5 months subsequently this patient took vitamin B complex by mouth only (for the latter 2 months more or less sporadically); the improvement in the amount and duration of the menstrual flow persisted until she stopped taking the B complex for a month on her own initiative. The menorrhagia recurred with her next period. On resumption of large oral dosage of B complex the subsequent period was normal.

CASE 11. R. P., aged 26 years, had had painful breasts and premenstrual tension for 2 years. She had a fissured, atrophic tongue, so sensitive she could not eat citrous fruits, a mild cheilosis and many symptoms characteristic of B avitaminosis. Both breasts were firm, nodular, and tender. Oral B complex therapy was instituted and there was moderate improvement in the breast tenderness and in the premenstrual tension over a period of 5 months; the glossitis improved so that she could eat acid foods without irritation and the cheilosis disappeared. Previously susceptible to sunburn, she now began to tan from solar irradiation for the first time in her recollection (this has been observed in several other patients on B complex therapy). The patient was then given combined oral and parenteral therapy; the breasts were no longer nodular and tender and there was no premenstrual tension whatever in two successive periods. After 1 month of combined oral and parenteral therapy there was a loss of 2 inches in the circumference of the bust and 1½ inches in the hips, although the body weight remained stationary at 212 pounds. Clothing previously tight-fitting was now loose.

CASE 12. M. W., age 15½ years, had had menometrorrhagia since the menarche at the age of 11 years; she had been bleeding continuously for 3 weeks when she was first referred for endocrine therapy. Rectal examination had revealed no abnormalities in the uterus or adnexa. A facial acne had been present since the menarche; this showed premenstrual exacerbations. For 4 months the patient had been on a greatly restricted diet for treatment of the acne, which had improved somewhat but was still present. She complained of constant nervousness and fatigue but was not aware of premenstrual tension. There were edema of the tongue, severe gingivitis, and seborrhea about the alae nasi. The thyroid was slightly and diffusely enlarged; the basal metabolic rate was plus 4 per cent. Oral B complex therapy was administered and the vaginal bleeding stopped in 2 days; there was no further bleeding until exactly 28 days after therapy was begun, when a period occurred which lasted 4 days without excessive flow. Unlike previous periods, the flow stopped abruptly without subsequent staining. The following 3 periods occurred at 30 day intervals and lasted 5, 5, and 4½ days, respectively, all with normal flow. During the 4 months of therapy there was no intermenstrual bleeding whatever. The avitaminotic lesions and the subjective symptoms all cleared up promptly. There was great improvement in general well-being. Despite restoration to the diet of previously interdicted foods, the residual acne cleared up completely.

CASE 14. M. G., aged 34 years, had had premenstrual tension and recurrently painful, nodular breasts for 10 days before each period. Associated with these symptoms she had a firm, tender mass in the upper outer quadrant of the right breast which had been present for more than 10 years. It had been diagnosed as a "cystic fibroma" and she was advised against having it resected. At the time of examination it was disc-shaped, approximately 3 by 3 by 1 centimeter in dimensions. Until a few months previously she had had severe menorrhagia, described by the patient as a "deluge," but the flow had more recently become scant. The periods previously occurred every 19 or 20 to 27 days, more recently every 28 days and lasted 4 or 5 days. She had a mild atrophic glossitis and cheilosis (there were exacerbations of the cheilosis before the periods) and seborrhea about the nose. The patient complained of waking up feeling tired in the morning, sudden headaches, irritation and tearing of the eyes, rapid visual fatigue, numbness and pain in arms and legs, recurrent vesicles in the oral mucous membrane, and a tendency of the skin to bruise from slight contusions. She received oral and parenteral B complex therapy over a period of 3 months. There was great improvement in the premenstrual tension and much less tenderness of the breasts; the mass in the right breast gradually diminished in size and after 3 months of therapy had completely disappeared. The avitaminotic lesions and symptoms all improved markedly. Among other changes, the skin bruised much less readily than before, and unlike the condition at the beginning of treatment, did not bleed from the puncture site following the injections.

Including Cases 7, 31, 32, and 38, there were 14 cases in this series in which signs and symptoms of B complex avitaminosis were associated with uterine myomas. All these patients had had menorrhagia, metrorrhagia or both and in 9 a hysterectomy had been performed. Four had been on an extremely deficient diet for many years; in 2 cases the restricted diet had been imposed for the treatment of allergy, in the other 2 the patient had an aversion to fruits and vegetables. One of the latter patients appeared for

Footnote for Table I.

Acknowledgment is made to Dr. M. M. Hartman, San Francisco, for the findings in Case 9, to Dr. Justus Kaufman, New York, for the reports of Cases 31 and 32, to Drs. George Blinick, H. C. Falk, and Leon Reidenberg, New York, for the gynecologic findings on several of the patients in this series, and to Miss Mae Glauberman and Miss Roslyn Rasin for assistance in treating patients whose cases are reported from the Beth Israel Hospital Endocrine Clinic. Vitamin preparations were kindly furnished us by Winthrop Chemical Co., Inc., S. M. A. Corporation, International Vitamin Corporation, Lederle Laboratories, Inc., Ayerst, McKenna Harrison (U.S.) Std., and Eli Lilly & Co.

treatment of unilateral cystic mastitis 8 months after the operation. Another patient who had had a supracervical hysterectomy, had bleeding from the cervical stump at two successive monthly intervals after the operation. A year later she came for treatment of cyclic tension and tenderness of the breasts for about 2 weeks of each month. In addition to the myomas, in 1 of these cases there was adenomyosis associated with large nabothian cysts in the cervical canal; in another there were cervical polyps.

Twelve patients with atrophic glossitis, cheilosis or both (and usually having other signs of B avitaminosis) were in the natural menopause when first seen; all 12 had a history of premenopausal menorrhagia.

ANALYSIS OF OBSERVATIONS

A number of the clinical implications of failure of the liver to inactivate estrogen in vitamin B complex deficiency while this organ continues to inactivate androgen, have been discussed in previous papers (5, 7, 8). Extension of the earlier clinical observations has raised several further points of considerable interest.

One important factor is that a number of patients who flowed usually for 5 or 6 days and had not considered this abnormal, subsequently flowed for not more than 3 or 4 days under B complex therapy. This indicates that it may be necessary to revise our concept of the normal range in the duration of the menstrual flow.

Characteristically, patients with only mild or moderate signs or symptoms of vitamin B deficiency, who had become accustomed to increased nervous tension, insomnia, tenderness of the breasts, a feeling of "fullness" or "puffiness," lumbar backache, headache, increased fatigability, lower abdominal cramps and the like, as premonitory indications of impending menstruation, reported after the first or second subsequent period while on B complex therapy, that the flow came on completely "without warning." Conversely, other patients, especially those who had signs of a more severe and more protracted deficiency and who were suffering from menorrhagia, reported that there had been dysmenorrhea for the first time while on vitamin B therapy, or that the pain had become more severe than before (this also occurred in one of the cases in which there were uterine myomas). In virtually every case in which this occurred there was little or no pain during subsequent periods while the nutritional therapy was continued.

Our observations in animals indicating that the estrogen-androgen equilibrium is altered in B complex deficiency, is of especial interest in view of the response of the clinical conditions here discussed to treatment with androgens. We believe that the therapeutic effect observed with the androgens is due to re-establishment of the estrogen-androgen equilibrium at a higher absolute level. Administration of the B complex, in contrast, reduces the body estrogen to the normal range and thus re-establishes the equilibrium at a physiologic level.

The majority of the patients in this series had a low basal metabolic rate. This was especially true of the patients with signs of severe or moderately severe nutritional deficiency. Administration of thyroid to these patients, in the absence of a vitamin B supplement, usually caused exacerbation of the signs and symptoms of the deficiency without significant change in the metabolic rate. The low metabolic rate in these patients may be the expression of a safety mechanism; the rise in body estrogen resulting from failure of inactivation in the liver depresses the pituitary with diminution in secretion of the thyrotropic principle. An additional factor is the observation reported by Williams and Kendall that administered thyroid is "less effective in promoting metabolic activity . . . . in a state of thiamin deficiency than it is when the intake of thiamin is adequate." This would explain the failure of response to thyroid observed in several of our patients and the improvement in this respect noted after adequate vitamin B complex therapy.

In 2 patients with enlarged thyroids a definite diminution in the size of this gland was observed after several months of therapy with vitamin B complex; this was sufficiently striking to be noticed spontaneously by members of their families. In neither of these cases, however, did the goiter completely regress during the period of observation. This is of interest in view of the well known observation that patients with goiters show periodic further enlargement of the gland during the latter part of the intermenstruum, when the body estrogen rises, and that administration of estrogen to some patients with hyperthyroidism leads to diminution in the basal metabolic rate (10).

Among other incidental changes observed in these patients, alteration in the skin and subcutaneous tissues were striking. A clearing and brightening of the complexion was usually one of the earliest changes observed on B complex therapy. This was noticeable in kodachrome photographs originally taken to illustrate the oral lesions and the changes under therapy. When first seen, in a number of the patients the skin was thin and hyperesthetic; large petechial hemor-

TABLE II.—GYNECOLOGIC AND ASSOCIATED DISORDERS OCCURRING IN PATIENTS WITH ATROPHIC GLOSSITIS OR CHEILOSIS OR BOTH AND WITH OR WITHOUT OTHER INDICATIONS OF DEFICIENCY IN FACTORS OF THE VITAMIN B COMPLEX

No. Patient Age	Gynecologic and associated disorders	Result of therapy with vitamin B complex
19 S.P. 26	Premenstrual tension	Striking improvement
20 M.L. 25	Premenstrual tension and breast tenderness	Subsidence of both conditions
21 B.S. 47	Menorrhagia; periods 8–9 days' duration; premenstrual tension and breast tenderness	Menstrual flow diminished to 3–4 days during 8 mo.; no premenstrual tension or breast tenderness
22 E.S. 33	Menorrhagia; premenstrual tension; cervical polyps (previously excised)	Gradual improvement
23 I.R. 20	Severe premenstrual tension and breast tenderness; continuous vaginal discharge with premenstrual exacerbations	Striking subsidence of all symptoms and diminution in duration of menstrual flow from 6–7 to 3–4 days
24 R.M. 46	Profuse menstrual flow 6–7 days' duration for more than 11 yr.; cystic mastitis and premenstrual tension	Marked relief of all symptoms over 9 mo.; duration of periods 3–4½ days
25 S.S. 43	Alternating menometrorrhagia and amenorrhea for 3 yr. (associated with severe mental depression)	2 successive periods 3 and 4 days' duration; mental symptoms improved rapidly
26 J.O. 28	3 episodes of menometrorrhagia following gains in weight of about 50 lb. from compulsive overeating	2 normal periods 6 and 4 days' duration without reduction of weight
27 F.S. 29	Premenstrual tension; premenstrual cheilosis and acne; profuse menstrual flow	No premenstrual tension; no recurrence of cheilosis or acne
28 R.S. 18	Premenstrual tension; premenstrual acne and (occasionally) stomatitis	Subsidence of all symptoms over 5 mo.
29 T.M. 20	Menometrorrhagia alternating with amenorrhea	First normal period since menarche, 4 days' duration
30 E.M. 32	Menorrhagia; premenstrual tension and breast tenderness for 5 yr.; endometrial polyp	Definite improvement in premenstrual symptoms and reduction in menstrual flow despite presence of polyp, later removed
31 A.C. 35	Menorrhagia; premenstrual tension; unilateral cystic mastitis; small uterine myoma	First normal period in 2 yr.; complete regression of nodules in breast; improvement in premenstrual tension
32 P.B. 48	Menometrorrhagia; multiple uterine myomas	Considerable diminution in menstrual flow but initial exacerbation of dysmenorrhea
33 R.A. 38	History of menorrhagia associated with benign cervical polyp, later excised; premenstrual cheilosis	Gradual subsidence of cheilosis; moderate diminution of menstrual flow
34 S.S. 18	Increase in duration of periods from 3–4 to 6 days past 2 yr.; premenstrual tension and breast tenderness	4 periods 4½ days' duration; no premenstrual tension; slight breast tenderness; exacerbation dysmenorrhea in 1 period, no pain thereafter
35 F.R. 34	Menorrhagia, 21 day interval, 7 days' duration; premenstrual tension	Successive periods 2, 4 and 4 days' duration, interval 26 and 32 days; no premenstrual tension
36 Y.F. 49	Profuse menstrual flow, 6 days' duration; premenstrual tension; premenstrual cheilosis	Periods 3½–4 days' duration, much reduced flow; no premenstrual tension
37 D.M. 37	Severe menometrorrhagia, recurrent after curettage; periods 9–11 days' duration	Flow much reduced in 2 successive periods, duration 6 and 5 days
38 P.E. 51	Severe menometrorrhagia 2 yr.; endometrial and cervical polyps; multiple myomas	Considerable diminution in amount and duration of bleeding, despite presence of polyps and myomas. Apparent decrease in size of uterus to palpation about 1/3rd in 2 mo.; patient then hysterectomized

TABLE II.—GYNECOLOGIC AND ASSOCIATED DISORDERS OCCURRING IN PATIENTS WITH ATROPHIC GLOSSITIS OR CHEILOSIS OR BOTH AND WITH OR WITHOUT OTHER INDICATIONS OF DEFICIENCY IN FACTORS OF THE VITAMIN B COMPLEX—Continued

No. Patient Age	Gynecologic and associated disorders	Result of therapy with vitamin B complex
39 C.S. 16	Menometrorrhagia for 3 yr.; very deficient diet	Normal period 4 days' duration after 3 wk. on oral B complex
40 P.K. 47	Menometrorrhagia; benign endometrial polyposis; nutritional deficiency and anemia secondary to enteritis of 30 yrs.' duration	
41 L.S. 34	Menometrorrhagia; endometrial hyperplasia and polyposis; premenstrual tension; restricted diet for peptic ulcer preceded excessive vaginal bleeding	
42 I.D. 39	Severe premenstrual tension and breast tenderness; profuse menstrual flow, normal duration	
43 L.A. 27	Premenstrual tension	
44 H.D. 42	Premenstrual tension and breast tenderness; recent increase in duration of periods from 3 to 6 days	
45 G.R. 41	Premenstrual tension and painful, nodular breasts	
46 F.R. 40	Menorrhagia; periods 14 days' duration	
47 R.S. 14½	Menorrhagia 1½ yr. since menarche; periods last 10–12 days; extremely deficient diet	
48 R.M. 37	Extreme premenstrual tension and breast tenderness since pregnancy 12 yr. before	
49 A.M. 30	Premenstrual tension; chronic cystic mastitis; premenstrual stomatitis since pregnancy 5 yr. before	
50 S.S. 42	Menorrhagia, increase in duration from 5–6 to 13 days; premenstrual tension	

Cases 40 to 50 were not treated for a sufficient length of time; they are included to show the correlation between nutritional deficiency and the gynecologic disorders.

rhages occurred from slight contusions and bleeding was almost invariable from the needle tract when hypodermic injections were made. The subcutaneous tissue was flabby and the fat pads over hips and abdomen were well developed. Following oral and parenteral therapy with the B factors for from several weeks to several months, the skin and subcutaneous tissue became firmer; the skin was no longer hypersensitive, did not show "black and blue spots" from minor contusions and there was no longer bleeding following hypodermic injection. In addition, 3 of the patients (Cases 7, 11, and 13) noted, to our mutual surprise, that there was diminution in the deposition of fat about the hips, thighs and abdomen without the loss of any weight. In one of these patients this was confirmed by actual measurement. The anatomic fat pads mentioned are specifically feminine attributes in the human being, and there is a great deal of evidence (derived both from spontaneous changes in body conformity in pathologic conditions and from the therapeutic use of estrogens and androgens) that the development of the characteristic female conformity is under the influence of estrogen. Thus, it is not surprising that, under favorable circumstances, reduction in the estrogen level (and alteration of the estrogen-androgen equilibrium) might affect the deposition of fat in these areas. Hooker and Pfeiffer, in studies on the rat, have shown significant changes in the skin and subcutaneous tissues following treatment with estrogen or androgen.

Bean (1, 2) has reported the occurrence of cutaneous vascular spiders and palmar erythema in patients with nutritional deficiency and has

related these changes to the effect of estrogen. Changes in the cutaneous blood vessels as a result of excess estrogen in nutritional deficiency, and regression under treatment with B complex, would explain the diminished tendency to bleeding we have observed.

In one of the cases reported here (Case 14) a mass in one breast that had been present for more than a decade, regressed under oral and parenteral B complex therapy until it was no longer palpable. The long persistence of this mass makes it not unlikely that some fibrosis was present, despite which complete (or virtually complete) regression occurred. In certain other cases, unpublished observations by one of us (G. R. B.) indicate that, in cystic mastitis with palpable masses of long duration, lesions that are presumably fibrotic have shown little or no significant diminution in size with oral and parenteral B complex therapy, even though pain and tenderness were well controlled. Breast nodules of shorter duration, which would be largely or predominantly epithelial in structure, and especially those which develop only during the latter part of the intermenstruum, regress rapidly and usually completely and do not recur under vitamin B complex therapy. Some of the masses that have persisted for months or years may show partial regression; this is probably due to diminution in size of the epithelial elements, leaving smaller palpable nodules of fibrous tissue. Whether or not the connective tissue elements of these lesions can be affected by reduction in the estrogen level through enhanced inactivation in the liver, remains to be decided by further study.

Studies on the endometriums of the cases with pathologic uterine bleeding are still under way, but certain preliminary observations may be mentioned. It is of course well known that bleeding may occur from endometriums of various types; among those observed by us in cases reported here there have been mucosas showing cystic hyperplasia and others in the early proliferative phase. All the patients having excessive bleeding from endometriums of these types showed striking improvement under vitamin B complex therapy. However, in an unpublished case of Novak's hyperplasia of the endometrium observed by one of us (G. R. B.) there was no significant diminution of bleeding under B complex therapy and little change in the histologic picture.

Of the patients with nutritional deficiency who were in the menopause when first seen, most were relieved of their flushes by administration of estrogen but continued to have a multiplicity of complaints such as headaches, nervousness, lightheadedness, insomnia, numbness and pain in the upper and lower extremities and the like. In several cases the estrogen was withdrawn and vitamin B complex was substituted. The avitaminotic lesions healed and the associated symptoms subsided. Even though the patients continued to have flushes they did not find them sufficiently disturbing to demand further estrogen therapy. It seems likely that many of the symptoms often associated with the menopause are really due to nutritional deficiency. And because the body estrogen is excessively high in B complex avitaminosis the vasomotor instability considered characteristic of the menopause may be made more severe by a rapid decrease in the body estrogen from this excessively high level. It may be that in the absence of nutritional deficiency with its associated failure of inactivation of estrogen in the liver, the total decrease in the estrogen would not be so great and the vasomotor symptoms correspondingly not as severe. The menopause may then be a physiologic phenomenon which does not require endocrine therapy.

The oral vitamin B complex preparations used in this study were usually given after meals in doses providing per day up to 9 milligrams and occasionally as much as 24 milligrams of thiamin, 9 milligrams or more of riboflavin and from 60 to 210 milligrams of niacin amide together with other factors of the vitamin B complex derived from rice bran, yeast, liver or all three. Patients with mild or moderate vitamin B complex deficiency usually respond well to any of these products; those with a more severe avitaminosis seem to respond better to the preparations containing extracts of liver. Parenteral administration provided an additional 40 or 50 milligrams of thiamin, from 5 to 5.2 milligrams of riboflavin, from 5 to 8 milligrams each of pyridoxine and calcium pantothenate and from 40 to 50 milligrams of niacin amide every second or third day. It has been our experience that parenteral administration of the B factors, especially when large doses of thiamin are included, is best made during the daytime; if given within 3 or 4 hours of bedtime, a restless night may may follow.

The necessary duration of oral and parenteral therapy with the vitamin B factors in cases of the types described cannot yet be decided. A few patients that received parenteral therapy over a period of several months were subsequently maintained successfully on moderate dosage of the B complex orally. Others have regressed promptly as soon as the oral dosage was reduced or the parenteral therapy discontinued. Since there are at present no adequate methods of determining precisely the nature, the degree or the reversibility of

the deficiency in a given case, the type, amount, and duration of therapy must be adjusted to the individual response. In perhaps the majority, and possibly in all the cases, large doses of the entire B complex must be administered indefinitely, especially as the average patient fails to correct the nutritional inadequacies of the usual American diet, or, having been persuaded for a time to correct it, will soon revert to one that is grossly deficient in the protective factors. And in several cases under treatment for nutritional deficiency for periods as long as 4 years, it has not been possible, after the vitamin reserves of the body had presumably been restored by intensive oral and parenteral therapy, to prevent recurrence of the lesions by diet alone. It has repeatedly been pointed out by many workers, but it will bear emphasis at least once again, that the infinitesimal dosages often employed, such as 1 or 2 yeast tablets 3 times a day, have little effect in the treatment of B complex avitaminosis. Reference is made to an excellent recent summary by Spies of the principles concerned in nutritional therapy.

SUMMARY

Observations in 104 patients provide further evidence, in extension of that previously reported, that menorrhagia, metrorrhagia, cystic mastitis, premenstrual tension, and probably uterine myomas as well, are caused by failure of the liver to inactivate estrogen owing to deficiency of factors of the vitamin B complex. Of 39 patients who were observed primarily because of the presence of lesions of nutritional deficiency, 37 had a history of one or more conditions related to excess estrogen. Of 52 patients whose main complaint was one of the latter conditions, and who were examined for evidences of nutritional deficiency, every one had signs or symptoms or both characteristic of B avitaminosis. Prompt and often dramatic responses were obtained in the gynecologic conditions with vitamin B complex orally, parenterally, or by both routes. Incidental changes are reported in the skin and subcutaneous tissues and in the deposition of body fat. Changes in the size and function of the thyroid are discussed.

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A NEW TECHNIQUE FOR USING THE LEVINE TUBE IN BILIARY INTESTINAL ANASTOMOSES

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COMPLETE obstruction of the bile ducts, whether from congenital atresia (5), strictures, inflammatory processes, or neoplasms, always presents a serious problem. Unless the biliary stasis is effectively relieved the outcome is invariably fatal. The primary aim, therefore, of any reconstructive operation is to provide adequate communication between the unobstructed segments of the biliary tree and the gastrointestinal tract. Much has been written concerning the relative merits of uniting the gall bladder or its bile ducts to the stomach, duodenum, and jejunum. Each operation has its merits and its disadvantages. As a rule, however, the operator is compelled to accept the simplest and most expedient measure of relieving the dangerous obstructions, for these patients are poor surgical risks.

GENERAL CONSIDERATIONS

In our experience there have been four fundamental complications which have proved most annoying, namely: leakage at the site of anastomosis, failure to relieve the obstruction, stenosis of the new ostium, and a latent cholangitis. An appreciation of the pathogenesis of these tantalizing complications affords the only solution to their prevention.

It is most difficult to obtain a watertight union between the distended gall bladder and the bowel because of the marked disproportion in the thickness of their respective walls. If the approximating sutures are drawn together too tightly they may cut through the thin wall of the gall bladder and liberate the septic bile. On the other hand, hyperperistalsis and gaseous distention may produce undue tension on the sutures causing them to cut through the gastrointestinal wall thereby producing an internal fistula with its lethal peritonitis. Walters has warned against the dangers of undue tension on the sutures being responsible for the majority of anastomotic leakages. On several occasions we have been chagrined to see what was thought to be a perfect anatomical anastomosis become separated. Apparently the distended gall bladder, which had permitted a satisfactory union, subsequently contracted as its intravesical pressure was reduced, thus initiating constant tension which caused the sutures to pull out.

Failure to relieve the biliary obstruction by reconstructive operations occurs much more frequently than is appreciated. Best and Hicken have demonstrated that cholecystoenterostomies may fail to relieve an obstructive jaundice simply because the cystic duct has been occluded by an unrecognized calculus or kink. They affirm that the presence of bile in the gall bladder affords no assurance that the cystic duct will continue to provide adequate drainage of the obstructed choledochus, for as soon as the distended gall bladder has been evacuated, the cystic duct may shrink sufficiently to close this conduit for the escape of the bile. Occasionally the plastic operation will so stretch or distort the gall bladder that it angulates or kinks an otherwise patent duct, hence the operation becomes futile. On one occasion a postoperative hemorrhage into the transplanted gall bladder occluded the cystic duct, thus negating the benefits of cholecystoduodenostomy. Again, an unrecognized stone in the common hepatic duct accounted for the failure of a cholecystogastrostomy. It is apparent that the operator has many facts to consider in selecting the proper corrective procedure.

Cicatricial closure of the anastomotic opening is a latent but troublesome complication. Ladd and Gross believe that this will not occur

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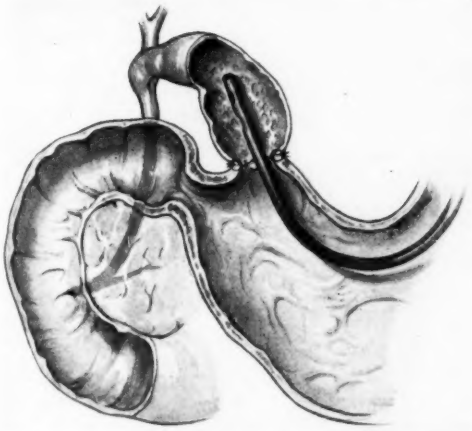

Fig. 1. A cholecystogastrostomy with the indwelling Levine tube. Note the retaining suture, which prevents the catheter from slipping back into the stomach.

Fig. 2. A cholecystoduodenostomy. The Levine tube has been coaxed through the pyloric ring. Retaining suture is illustrated in this drawing also.

if care has been taken to unite the mucosal surfaces of the two component structures. The mucosa-lined stoma inhibits the chemical irritation of the deeper muscular layers, thus minimizing scar formation. Walters emphasizes the necessity of making the orifice large enough to compensate for the inevitable postoperative edema around the line of suture. If this is not done, the walls of a small stoma may become contiguous and adhere to each other. McArthur devised a special indwelling rubber tube which he placed in the anastomotic opening to keep the newly formed estuary open until the edematous phase has subsided. Occasionally these tubes failed to pass on into the gastrointestinal tract and, becoming plugged with the detritus from the biliary tree, they effectively occluded the new orifice.

Latent cholangitis and suppurative hepatitis may complicate any and all types of biliary anastomoses. Ascending infection combined with the chemical irritation from the reflux of pancreatic and gastrointestinal secretions quite naturally invite such disasters (2). Zollinger devised the tubular gastric stoma in hopes of overcoming this difficulty. Lahey suggested that the reflux phenomenon was less when the bile was emptied into the jejunum than when other segments of the gastrointestinal tract were selected for the reconstructive operation. Ladd and Gross, however, believe that these complications are not so dangerous as some authors contend, for they report several cases in which patients were apparently well 16 years following cholecystogastrostomies. These operations are never elective and all hazards must be assumed if an attempt is to be made to relieve the complete biliary stasis.

TECHNICAL CONSIDERATIONS

The selection of the type of biliary intestinal anastomosis to be employed is determined by the site of the obstruction, the patency of the ducts, and the versatility of the surgeon. The simplest and most expedient method of relieving the occlusion should be utilized. Experience has proved that certain principles must be followed if a satisfactorily functioning stoma is to be obtained.

1. The size of the artificial stoma must be adequate to permit the free drainage of bile and not large enough to invite the regurgitation of intestinal juices into the biliary tract. If the gall bladder and bile ducts are dilated, one must allow for the inevitable shrinkage which occurs when these structures regain their normal tonus. This "contracting phenomenon" apparently accounts for many "nonfunctioning stomas," particularly if the choledochus or common hepatic bile ducts are utilized. Like-

Fig. 3. A cholangiogram made on the operating table to test the patency of the cystic duct. This was performed before the reconstructive operation was done. Observe the enormously dilated common bile duct, which is so completely occluded that none of the diodrast escapes into the duodenum. *1*, Gall bladder; *2*, dilated common bile duct; *3*, patent cystic duct.

Fig. 4. A postmortem cholangiogram made by introducing the contrast media through the cholecystogastrostomy stoma. Note the enormously dilated common bile duct which drains through the patent cystic duct into the gall bladder and through the gastrocholecystic stoma into the stomach. This patient died of pulmonary embolism on the 3d postoperative day.

wise, it is much easier for any postoperative edema to close the stoma if it should happen to be too small.

2. Extreme care must be exercised to render the anastomoses watertight (2). This can be accomplished by the use of the same technique as is employed in performing a gastroenterostomy. The inner layer of sutures securely unites the mucosal linings of the two component organs while the outer or reinforcing layer, firmly approximates the muscular and serosal tissues. Several retaining sutures are placed above and below the stoma to absorb any tension which might be exerted from distention or motion of the gastrointestinal tract. Whenever possible some fatty tissues from the omentum, the gastrohepatic and the duodenohepatic ligaments are securely anchored around the fusion line to minimize the dangers of leakage.

3. During the past 3 years we have employed a new technique which insures the functional integrity of the anastomoses. It has been employed satisfactorily for cholecystoenterostomies, choledochoenterostomies, and hepaticoenterostomies. The ease of execution and the immediate relief of the biliary obstruction certainly recommend its use.

The technique is as follows: During the preoperative period the stomach is repeatedly lavaged thus removing accumulated fluids and residue. Just before the operation is begun a previously sterilized Levine tube is passed into the stomach. When the new openings have been made, let us say between the stomach and the gall bladder, the tip of the catheter is pulled through the gastric incision and inserted into the lumen of the gall bladder so that 2 inches of the tube lies within the gall bladder cavity. The tube is then securely anchored to the gastric mucosa and muscularis by fine No. 00000 chromic catgut sutures (Fig. 1). This prevents the catheter from slipping back into the stomach. When a choledochoenterostomy is performed the Levine tube is coaxed through the pyloric ring and then introduced into the common bile duct (Fig. 2). A similar procedure has been followed when working on the hepatic ducts or the jejunum. It has been most pleasing to observe the ease with which

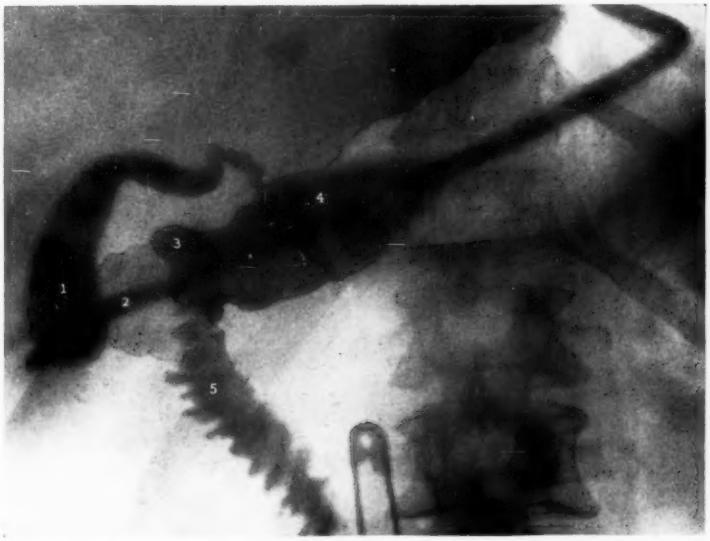

Fig. 5. An operative cholangiogram made by introducing diodrast into the Levine tube. Note that the contrast media traverses all of the duct system and escapes through the newly formed stoma into the stomach and duodenum. *1*, Gall bladder; *2*, Levine tube; *3*, escaping media into the stomach; *4*, dilated common bile duct; *5*, diodrast in the duodenum.

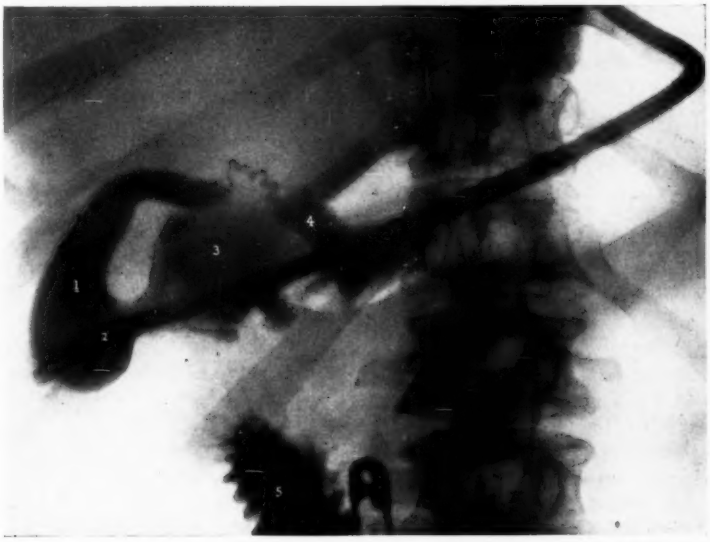

Fig. 6. Same patient 10 days later. The delayed cholangiogram demonstrates an effectively functioning cholecystogastric stone. Note that there has been no leakage of the contrast media into the peritoneal cavity.

the anastomoses can be made around the indwelling catheter.

The use of the Levine tube has the added advantage of permitting the visualizing cholangiographic studies to be made while the patient is on the operating table (3). As soon as the anastomosis has been completed, and before the abdomen is closed, an assistant introduces 20 to 50 cubic centimeters of sterile diodrast into the external oriffice of the Levine tube and an immediate x-ray picture is taken. If the contrast media traverse and fill all of the biliary radicals one is safe in assuming that the ducts are patent and that the bile can follow the same channels and escape into the gastrointestinal tract. Any obstructive lesion produces a recognizable deformity and corrective steps can be promptly employed. If the suture line is impervious to the diodrast there will be no leakage of bile. Should one detect a slight seepage of the contrast media at any given point of the anastomotic line this defect can be corrected before the peritoneum is closed.

Even under ideal conditions both choledochoenterostomies and hepaticoenterostomies present many technical difficulties. The small caliber of the ducts and the deep cavities in which one must work merely add to the handicaps. When the Levine tube is used, however, it forms an excellent pattern around which the new stoma can be made. If the selected catheter has the same diameter as the bile ducts then adequate drainage is obtained and any seepage prevented. The semiflexible catheter provides a firm support for the stoma thereby preventing postoperative occlusion from edema, kinking, or contact fusions. By the time the catheter is ready to be removed there will be a firm cicatricial reinforcement around the anastomosis.

The postoperative courses of all our patients have been most pleasing. The immediate relief of the complete biliary obstruction causes the jaundice to subside, the liver regains its functions, and improvement is most rapid. By means of a continuous suction to the external end of the Levine tube the thick, viscid bile can be effectively aspirated, thereby lessening the hydrostatic tension on the suture line. If the diseased biliary tract should contain thick mucus, biliary sand, blood clots, or pus, this undesirable material can be removed by aspirating lavages, hence insuring adequate drainage.

Routine postoperative cholangiograms are made on the 7th to 10th postoperative days. If the bile ducts have regained their normal size and tone, and if the bile has no abnormal appearance, then the Levine tube can be removed with impunity. The ability to remove the indwelling catheter overcomes the objections which result from the use of the McArthur tube. No residual rubber tubing is left in the stoma to become incrusted and obstructed. As soon as the Levine tube has been removed, the bile flows into that segment of the intestinal tract where it can best aid in the digestion and assimilation of food. This does away with the annoying and distasteful dressings which necessarily accompany all forms of external fistulas.

REPRESENTATIVE CASES

CASE 1. A.F., male, aged 76 years, had complained of a progressive painless jaundice for 6 weeks. Anorexia, nausea, vomiting, weakness and loss of 21 pounds of weight were his main concern. Palpation disclosed a small, firm, fixed mass in the epigastrium. His icteric index was 135, prothrombin time was 32 seconds. Roentgenograms were negative for cholelithiasis or malignant invasion of the lungs or skeleton system.

When the abdomen was opened a large, tense, noncalculous gall bladder was found. No stones were present. The dilated common bile duct measured 3 centimeters in diameter. The pancreas was about twice normal size and had encircled the choledochus in such a manner as to produce a compression occlusion of the ampulla of Vater. Biopsy demonstrated an adenocarcinoma of the pancreas.

The extensive pancreatic involvement precluded any possibility of resecting the malignant tissue so a cholecystogastrostomy was performed. The Levine tube, which had previously been passed into the stomach, was coaxed through the cholecystogastric stoma, so that its tip lay well within the gall bladder cavity (Fig. 1). In order to test the patency of the cystic and common hepatic bile ducts, the Levine tube was injected with 45 cubic centimeters of diodrast and an x-ray picture was taken. The resulting cholangiogram revealed that the contrast media had passed from the gall bladder into all of the biliary radicals, hence these patent ducts afforded an open drainage channel by which the static bile could escape into the stomach (Fig. 3). As soon as patient was returned to his room, continuous negative suction was applied to the indwelling Levine tube and during the first 72 hours 2,515 cubic centimeters of black viscid bile was aspirated. He died on the 72d postoperative hour from a massive pulmonary embolus.

Fig. 7. A drawing of a cholecochoduodenostomy for fibrosing pancreatitis. Note the Levine tube passing through the newly formed stoma into the obstructed common bile duct.

Fig. 8. Hepaticoduodenostomy. Note the double lumined decompression tube which keeps the stomach and hepatic ducts decompressed. The common bile duct is a collapsed fibrotic strand of tissue.

The postmortem picture was described by Dr. John H. Carlquist as follows: "The anastomosis appears to be firm, secure, and presents no evidence of bile seepage. The mucosa of the gall bladder and stomach had fused in a very smooth manner and the bile ducts were completely decompressed (Fig. 4). The tip of the Levine tube extended well into the lumen of the gall bladder and had effectively relieved the gall bladder and bile ducts of their contents. There was no evidence of inflammation or pressure necrosis at the point where the tube passed through the newly made stoma."

CASE 2. A farmer, aged 60 years, had been troubled with an "itching jaundice" for 3 weeks. He gave no history of an antecedent biliary colic or indigestion. Progressive weakness characterized by a loss of 34 pounds of weight were his presenting complaints. The icteric index was 95; prothrombin time, 23 seconds; blood urea nitrogen, 48 milligrams per 100 cubic centimeters of blood; and the urine contained urobilin.

When the abdomen was opened a greenish black liver was found to extend 2 inches below the costal margin. The thin-walled gall bladder was about four times normal size and contained 175 cubic centimeters of viscid black bile. The choledochus measured 2½ centimeters in diameter. The head of the pancreas was enlarged, firm, and nodular, and had completely surrounded the common bile duct, thereby compressing its lumen. No stones were present. As the dilated gall bladder and the stomach were contiguous, the two were anastomosed together, thus providing an escape into the gastrointestinal tract for the stagnant bile (Fig. 5). The Levine tube was pulled into the stomach and drawn through the newly formed stoma, so that it lay within the lumen of the gall bladder. It was anchored to the stomach wall by No. 80 cotton suture, so as to prevent its slipping back into the gastric cavity. By the injection of diodrast into the Levine tube, the contrast media made visible the cystic duct, thus showing it to be patent (Fig. 6).

Postoperative course was most pleasing. On the 5th postoperative day the jaundice had disappeared as evidenced by an icteric index of 18. A delayed cholangiogram was made on the 10th postoperative day—the common hepatic duct and the finer biliary radicals were no longer dilated and the contrast media flowed through the stoma into the stomach. During all this period there was no leakage of bile from the abdominal incision. Two days later the Levine tube was removed. He was discharged on the 18th postoperative day. It is now 6 months since operation and he has gained 24 pounds in weight and is working every day. The pancreatic tumor had increased in size but there has been no recurrent jaundice.

CASE 3. R.S., housewife, aged 56 years, had had recurrent attacks of "gall stone colic" during the past decade. Five years ago her gall bladder "which contained many small stones" was removed. While convalescing from the operation she suffered three attacks of "gall colic." Three years ago she had a protracted siege of colic associated with jaundice. Since that time she has been jaundiced on four different occasions, the last episode being 1 week prior to admission. Icteric index was 85, blood urea nitrogen was 42 milligrams per 100 cubic centimeters blood, prothrombin time was 35 seconds, and the urinary urobilin was 3 plus.

No difficulty was experienced in exposing the common bile duct. The supraduodenal segment meas-

TABLE I.—RESULTS

Patient	Disease	Operation	Days tube removed	Result
M. 76	Cancer pancreas	Cholecystogastrostomy		Died 72 hrs. Pulmonary embolus
M. 60	Cancer pancreas	Cholecystogastrostomy	12th	Living 6 months later. No jaundice
F. 63	Cancer pancreas	Cholecystogastrostomy	9th	Died 2 months. No jaundice
M. 66	Cancer pancreas	Cholecystoduodenostomy		Died 5th day after operation. Hepatic death
M. 76	Cancer pancreas	Cholecystogastrostomy	10th	Well 8 months. No jaundice
M. 66	Cancer pancreas	Cholecystogastrostomy	14th	Died 3 months. Carcinomatosis
F. 56	Chronic pancreatitis, common bile duct stones	Choledochoduodenostomy	9th	Well 26 months
F. 46	Stricture common bile duct	Hepaticogastrostomy	16th	Well 38 months
F. 50	Pancreatitis; stones common bile duct	Removal stones. Choledochoduodenostomy	12th	Well 36 months
F. 56	Stricture common bile duct	Choledochoduodenostomy	12th	Well 22 months
F. 56	Stricture of ampulla of vater	Choledochoduodenostomy	10th	Well 16 months

ured 3 centimeters in diameter. The enlarged succulent pancreas completely invested the ampulla of Vater and precluded any possibility of palpating a choledochal stone. In an attempt to expose the retroduodenal portion of the choledochus by mobilizing the duodenum a rather brisk hemorrhage was encountered. The choledochus was opened but its lower segment seemed obstructed, either with a stone or inflammatory tissue. The annoying hemorrhage prevented further exploration. In order to relieve the intense biliary stasis a choledochoduodenostomy was performed (Fig. 7). The Levine tube was pulled from the stomach into the duodenum and its tip threaded up into the common hepatic duct. The anastomosis was reinforced around the tube and the abdomen was closed.

The Levine tube was attached to a decompression bottle and 860 cubic centimeters of bile was recovered during the first 24 hours. Patient made a rapid recovery. On the 9th postoperative day the aspirated material contained duodenal content indicating that the tube had slipped out of the common hepatic duct into the duodenum. Apparently the No. 00000 chromic catgut suture which had been used to anchor the Levine tube had been absorbed. By this time her icteric index was but 20 and the stools had a normal brown color. Hence the Levine catheter was removed. She was discharged on her 18th postoperative day and has remained well during the past two years.

CASE 4. Hepaticoduodenostomy. A. J., housewife, 46 years old, had had her "gall bladder removed 6 months previously." She did very well until 1 month ago when she began to complain of anorexia, nausea, and a continuous jaundice. The icteric index was 75, prothrombin time 48 seconds, and the urine contained bile and urobilin.

A laparotomy disclosed an enlarged, congested, and deeply pigmented liver. The common hepatic bile duct was as large as one's thumb and seemed to end in a small fibrotic strand at the point where it joined the choledochus. In spite of meticulous exploration we were unable to identify the common bile duct, even after exploring the retroduodenal area. As the stomach lay against the dilated common hepatic duct the two were anastomosed. A No. 16 Levine tube, which had been previously passed into the stomach, was threaded through the new stoma and its tip was inserted into the hepatic ducts. The main portion of the tube was securely anchored to the stomach wall with No. 00000 chromic sutures (Fig. 8).

During the first 48 hours 1565 cubic centimeters of thick greenish bile was recovered from the Levine tube by means of continuous suction. The jaundice rapidly subsided, for on the 6th postoperative day the stool had a normal color. A delayed cholangiogram was made on the 16th day which revealed the stoma to be working, for the diodrast, which was injected into the common hepatic duct, rapidly escaped into the stomach. The Levine tube was removed on the 21st postoperative day and the patient is now well, 38 months after her operation.

RESULTS

To date we have employed the principle of the indwelling Levine tube for decompressing an obstructed biliary tree in 11 cases. Six of these patients had such an extensive adenocarcinoma of the pancreas that resection or excision of the malignant tissue was impossible. Our aim has been to relieve the biliary obstruction thereby correcting the tantalizing itching which invariably complicates the intense jaundice. Table I reveals that there were but two operative deaths, one from a massive pulmonary embolus, and the other from hepatic insufficiency.

Experience dictates that, in dealing with cancer of the pancreas, choledochoenterostomies are more effective in relieving the biliary stasis than is a cholecystenterostomy. In two instances autopsies have revealed that the enlarging pancreatic tumor may produce so much tension and distortion of the gall bladder that it causes either a kinking or tension occlusion of the cystic duct, thereby reproducing the biliary obstruction. In each of these cases the common duct was still dilated and had it been anastomosed to the stomach or duodenum such unfortuitous complications would have been obviated.

CONCLUSIONS

A new technique for biliary intestinal anastomosis is described, the essential feature being the use of an indwelling Levine tube for continuous decompression of the obstructed bile ducts. The Levine tube, which has been passed into the stomach just before beginning the operation is pulled through the newly formed stoma, so the tip of the catheter lies well within the lumen of the obstructed segment of the biliary tree. A watertight anastomosis is made around this catheter. Continuous suction keeps the bile ducts completely decompressed and hence insures a well functioning internal biliary fistula. Cholecystoenterostomies, choledochoenterostomies, and hepaticoenterostomies have all been performed by this technique. The excellent results which have been obtained, combined with the simplicity of the procedure, strongly recommends its use.

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CARE OF THE INJURED IN COMBAT ZONES

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AS YET not much data are available from our own medical officers in foreign theaters of war upon which to base the teaching of first aid and early hospital care of battle casualties. Thus, in training our medical officers and men who are to serve in units overseas we must rely on such modifications of the methods of World War I made necessary by changed conditions of warfare as have come to us from other sources.

The reports from the British have been very helpful. As an example, Colonel Gillespie, British Army Medical Services Liaison Officer, on duty at Carlisle Barracks, has distributed some highly informative notes on battle casualties in the Middle East as a result of the fighting in September, October, and November, 1942. These valuable first hand facts, proved in the actual crucible of combat experience, have been most illuminating and have been borrowed from freely.

Nearly a year ago the War Department issued *Training Manual No. 8–210* entitled "*Guide to Therapy for Medical Officers.*" This booklet was compiled largely from recommendations of the subcommittee of the Division of Medical Sciences of the National Research Council and is excellent because of its clarity, conciseness, and its emphasis on essentials.

The Surgeon General issues from time to time circular letters regarding various subjects. These letters represent in concise form a directive or a bulletin, and have been found to be a decidedly useful way of distributing new factual material.

Finally, there are appearing in British and American surgical journals, both civilian and military, a stream of articles on war surgery that contain valuable contributions to our fund of knowledge of this important field.

Much of what is to be considered here may seem elementary or commonplace. It is, however, of importance and for this reason it is presented without further apologies.

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PRINCIPLES OF FIRST AID IN TREATMENT OF SHOCK AND HEMORRHAGE

Primary objectives are to save life, to relieve pain, to arrest hemorrhage and to combat shock; of urgent need also are the prevention of avoidable contamination by protection of the wound against additional soiling and the alleviation of discomfort and apprehension.

Most severe accidents, injuries, or wounds are associated with some degree of shock; in burn cases this is especially true. The importance of immediate therapy is such that it should take precedence over all other except the arrest of profuse hemorrhage and the relief of mechanical obstruction to respirations.

Shock is a state characterized by profound alterations in the physiology of the circulatory and respiratory systems. There is a lowered blood pressure, rapid heart action with weak pulse, and shallow rapid respiration; there is pallor weakness, and often subnormal temperature. The recognition of a state of shock is most important. The medical officer should at least suspect it on sight and proceed at once to confirm his suspicions.

While everyone is no doubt familiar with the types of injuries that are usually associated with shock, it should be pointed out that the nature of modern warfare is peculiarly constituted to provide the shocking type of trauma; these include blast injuries, crushing due to mechanized equipment. Burns are frequent in land as well as naval action since much of the fire power is mechanized and explosions and fires are productive of many serious burns.

Punctured wounds due to machine and automatic rifle fire as well as to shrapnel and hand grenades are similar to those seen in the last war.

Treatment of shock. The ideal treatment of shock is preventive and the change in the pic-

ture is a real triumph of modern surgery. Preventive measures are: (1) gentleness in handling and transporting injured persons, especially in cases of major fracture; (2) prevention and control of hemorrhage; (3) prevention of or correction of dehydration; (4) prevention of loss of body heat; placing of wounded in (5) Trendelenburg position. Active measures include: (1) relief of pain by administration of morphine in adequate doses —at least ½ grain for a severely burned adult; (2) the use of plasma in adequate doses—burn cases need large amounts; the hematocrit reading is a useful guide as to quantity required; (3) avoidance of any disturbance and particularly any surgical procedure or even extensive examination while shock is being successfully combatted. If operation is imperative, shock may be combatted by one team while another proceeds with the operation; such cases are desperate and are the exception.

When a casualty arrives at a dressing station the following steps are in order: (1) Look at the tag and see what has been done already and read any notes that may appear thereon; (2) transfer patient from stretcher to warmed bed; (3) remove clothing with minimum fuss, shears being used if necessary to avoid further disturbance; (4) note general condition; (5) examine for hemorrhage, either external or internal, crushing injuries, nerve injuries; (6) record pulse, respiration, and blood pressure every 15 minutes; (7) cover with blanket, permit rest and quiet; (8) observe patient frequently; (9) if patient is pulseless when first seen or is obviously in grave shock, leave him on stretcher. Don't undress him but administer plasma before anything else is done.

Resuscitation wards. The resuscitation ward in desert warfare as developed by the British has played a very important rôle in surgery of the combat zone. The most serious cases are sent here and upon the efficiency of resuscitation and upon the selection of the optimum moment for operation, the life of these wounded may depend. The work of the field transfusion units is highly praised in accounts from the Middle East.

However, a word of caution is sounded: so effective is their work that it is felt that resuscitation may become an end in itself and not be regarded in the light of the clinical picture. If, in spite of transfusion, shock continues one should consider that a continuing cause may exist, such as active bleeding, peritonitis, anaerobic infection, or absorption from mangled useless limbs; if one of these is responsible further transfusion is as useless as pumping a punctured tire. Thus, it is important that frequent regular inspection of patients in this ward be made by a surgeon who can reassess the cases with the resuscitation officer. Once the "one best time" for operating on a patient is gone it will never return.

Human albumin is now being procured in such form as to make its use intravenously relatively satisfactory as a blood derivative for the treatment of shock and burns. It has great advantages where space is a problem. It should be pointed out that its use in patients in whom a concealed hemorrhage is a possibility is not without risk of complications; its ability to produce a rapid rise in blood pressure may cause bleeding from wounds closed while the pressure is low and large hematomas may follow. If the neck is involved pressure symptoms might be serious. Similarly great caution should be used in administering the drug in casualties with stab or gunshot wounds of chest or abdomen until large bleeders have been ligated. It is probable, however, that for warfare where space is at a premium the use of albumin will be expanded. The maximum amount of albumin which should be administered to any one patient is probably 250 grams. The initial dosage is one unit, i.e. 100 cubic centimeters of a 25 per cent solution, roughly equivalent to 500 cubic centimeters of citrated plasma.

The British in the Middle East consider blood definitely superior to plasma for men who have suffered severe hemorrhage. It fits them for operation more rapidly and its effect is more sustained. However, plasma is still supplied to forward units since there blood cannot be kept in condition.

After shock and hemorrhage are disposed of the simplest emergency first aid involves: (1) removal of foreign bodies; (2) implantation of a sulfonamide in the wound to arrest bacterial activity; (3) application of large sterile

dressing bandaged with moderate pressure; (4) immobilization of the injured part, splints being used when indicated.

These steps can be carried out as actual first aid measures before the patient is transported back to a hospital where formal débridement or other definitive treatment can be carried out. It is probable that the introduction of sulfonamides into a wound as an immediate first aid measure has made it possible to debride successfully after a longer lapse of time than if no sulfa drug had been implanted at the time of the injury. When there is considerable delay in transporting the injured soldier back to the hospital this is a matter of importance.

TREATMENT OF WOUNDS OF SOFT PARTS

In civil life flesh wounds are often seen within 1 or 2 hours after injury. Also the nature of the wound makes débridement and primary suture frequently acceptable in these cases. That conditions are much less favorable in war wounds has long been appreciated. However, it appears that the warning must again be emphasized that, as expressed in a note from a Middle East surgeon "War Surgeons . . . should know that primary suture in forward units is unsuccessful and may be disastrous . . . some wounds were sutured and arrived septic." Thus, it seems clear that in wounds received in combat areas, primary suture after débridement is not to be recommended. The principles of treatment are the same everywhere, namely: (1) control of hemorrhage; (2) removal of contaminating organisms; (3) removal of damaged or devitalized tissue; (4) prevention of further injury and further contamination with bacteria. The steps in the treatment of a wound of the soft parts briefly are the following:

1. Under an anesthetic and if indicated a tourniquet to control bleeding, the damaged tissue is removed, major bleeders are ligated, and the wound is protected from further contamination by a sterile compress or pad.

2. As soon as possible preparation for débridement is carried out by washing the skin adjacent to the wound with a nonirritating neutral soap and water with cotton sponges; benzene is useful to remove grease or dirt; followed by sponges soaked in 70 per cent alcohol until the area is thoroughly cleaned.

3. Débridement is done under strict asepsis. This implies operating room technique including masking of the nose and mouth. A narrow rim of damaged skin is excised. Devitalized tissue, blood clots, and foreign material are removed by means of clean sharp dissection. A fresh set of instruments is used for the dissection of the depths of the wound. Meticulous hemostasis is accomplished with fine suture material (catgut, silk, or cotton). After débridement the wound should be irrigated carefully and extensively with sterile normal saline solution until all minute particles of blood, tissue, and débris have been flushed away; the wound is then lightly dusted with sulfanilamide powder and packed lightly with sterile gauze or with a plain vaseline gauze. The outer dressings should encircle the wound—sterile sheet wadding is useful for this purpose. In wounds of the extremities the tips of the fingers or toes should be left exposed for observation of the circulation. In the Egyptian campaign some wounded were transported with dressings that were loose on arrival so that wounds became exposed; "a dressing applied forward has to stand the test of many hours of transport, of transfer from stretcher to bunk and vice versa, and in many cases, of a restless patient. Strapping over the dressing itself and a firm bandage over that, offers the greatest security."

4. When indicated splinting of the parts with plaster or other available splints should be done. This is particularly needed when muscles or tendons have been out.

5. In combat zones, as mentioned before, no attempt should be made to close wounds or to suture divided tendons or nerves.

The following notes from the Egyptian campaign are of value in warning against primary suture of War Wounds.

"Despite the fact that primary suture in forward units is not advisable and may be disastrous, suture or partial suture of large sucking wounds has been attempted in the Middle East campaign. Such wounds were found to arrive at the base extremely septic so that the stitches had to be removed leaving once more a sucking chest wound complicated by cellulitis of the chest wall and tissues that can no longer be approximated. The British advise that

these wounds be trimmed and hemorrhage arrested but no attempt should be made to close either by sliding flaps or by suture. They must be made air-tight by pads of gauze or vaseline gauze shaped to fit the wound, applied over sulfanilamide powder and pressed firmly in position; with small wounds the pad may be secured by elastoplast with a firm bandage over it to apply pressure; with large wounds two or three sutures of stout silkworm gut should be put through the skin edges and tied over the pad. Wounds so dressed arrive with no more than a local infection and will either close under a series of pads or can be sutured when the first reaction of the tissues is over."

Amputation stumps that have been sutured arrive at the base septic even if drains have been used at the angles. While stumps left open are painful and require a long healing period they are preferable. The most satisfactory immediate dressing is vaseline gauze laid on the raw surface and held in place by several sutures holding the flaps but not approximating them. The British consider "the true guillotine amputation which divides all structures at the same level a surgical crime that no military or surgical excuse can condone."

Some of the British are of the opinion that so great has been the controlling influence of internal administration of sulfonamides on the incidence of sepsis that extensive débridement on the scale considered necessary in the last war should no longer be required. The essentials are removal of foreign material and necrotic tissues, and relief of tension throughout the wound track so that deep accumulations may escape more readily to the surface rather than along intermuscular planes. Therefore, in place of débridement the trend has been toward "trimming operations."

The "wound trimming" consists primarily of incision of the skin and fascia along anatomical planes to lay open all portions of the wound and remove rapidly loose tags and muscle shreds. Thereafter local application of sulfanilamide powder and strip of vaseline gauze laid down to the depths of the wound complete the procedure. The skin, considered of all tissues most viable and most resistant to infection, should be left alone. The popularity of the "trimming" method is growing, judged by reports from the Libyan campaign area, and there are increasing warnings in recent medical literature against indiscriminate sacrifice of skin. A surgeon can "trim" about 3 cases in the time spent débriding 1, the patients require less anesthetic, return from the operation in better shape, and the wounds appear to arrive at the base in as good condition as when débridement had been done.

TREATMENT OF FRACTURES

In general the principles that apply to the treatment of fractures in civil life still hold. Shock, hemorrhage, or late infection are common causes of a fatal outcome; since all of these factors are favored by transportation inadequately protected by traction splints the principle of "splint 'em where they lie" still obtains. If splinting is prompt, before muscle spasm sets in the advantages are obvious.

If the fracture be compound, after clothing has been cut away and hemorrhage controlled, an occlusive sterile dressing of adequate size is applied, but no attempt is made to clean or débride the wound. The appropriate traction or coaptation splints are then applied depending upon the location of the fracture. If a fracture or a wound involves a joint, the treatment is the same as for a compound fracture; no attempt is made to clean or débride the wound. As soon as splints have been properly applied transport to a hospital for definitive treatment is in order.

Short plaster affording inadequate immobilization is a serious fault that has been observed at the battle front. For injuries of the hand or wrist plasters should extend from metacarpal neck to the head of the radius; those of the foot and ankle to beyond the toes and up to the neck of the fibula.

Immobilization of injuries to the thigh and knee joint can be accomplished by a splint called the extension-plaster-Thomas combination, spoken of as the "Tobruk plaster." After any required surgical care has been given to the wound an effective method of applying this splint is as follows:

1. Strapping extension is applied on each side of the thigh and leg, with care to avoid circular strips of bandage.

2. Traction is then applied to the foot—not the extensions—by an assistant or orderly.

3. A broad strong long plaster slab is applied to the posterior part of the thigh and

calf round the back of the heel, which is well padded, and along the sole of foot. The plaster should encase at least half the circumference of the leg and thigh and should be carefully molded to the shape of the limb with the knee supported in slight flexion.

4. A Thomas splint is applied with flannel or canvas "cradles" slung under the thigh, knee, and calf from the side bars of the splint, the ring being pushed well up in the groin.

5. The extensions are wound once round each side bar and tied firmly to the end of the splint.

6. Two large rolls of wool are placed on each side of the thigh to support the site of injury. The bony areas of knee and tibia are padded.

7. A circular plaster is applied round everything, bars of Thomas, canvas supporting cradles, leg thigh, etc.

The traction used is fixed to the end of the Thomas splint, the counter traction being the ring of the splint on the ischiopubic ramus. Longitudinal movement of the leg in the plaster is necessitated only if the extensions slip, and this should not occur during the first week if the splint is carefully applied. It must be emphasized that this method is for transport only and not to be used for the treatment of the injury.

The precautions are: (1) careful padding of bony points and the back of the heel; (2) placing the foot at right angles; (3) placing the knee in 15 to 20 degrees' flexion, not more, otherwise transport is more difficult and swelling of the foot may occur; (4) getting the extensions tight before applying circular plaster.

Alternate method is to use a complete plaster instead of a plaster slab. If this is done, precautions are: (1) splitting plaster before final fixation; (2) seeing that the extensions pass easily through holes in the plaster near the ankle—and do not pull on the plaster itself—otherwise sores on the dorsum of the foot and back of the heel are inevitable.

Injuries of the humerus were transported in plaster extending from the acromion down to the wrist. It was found that to transport these casualties in this manner was most uncomfortable and that the method failed to maintain immobilization of the fracture site. It was found that a comfortable method, particularly for transport, consisted in maintaining fixation by a "U" plaster extending from the base of the neck over the point of the shoulder down the outer side of the upper arm, under the olecranon and upper part of forearm, finishing on the inner side of the upper arm just short of the axilla. The arm is then bandaged to the thorax by means of two or three plaster bandages; a collar and cuff completes the support to forearm and wrist.

In badly comminuted fractures, especially when damage to the radial nerve is present, a long plaster slab on the volar aspect of the forearm and hand is necessary as additional support. This should be fixed to the forearm by a cotton bandage which does not extend lower than the wrist joint.

The notes made on the plaster by the surgeon who first treated the wounded man were of invaluable aid to the next surgeon to see the patient, as it helped him to assess the surgical disposal of the patient on arrival. These sketches are made with indelible pencil directly on the wet plaster.

PERIPHERAL VASCULAR INJURIES

These are among the most important injuries received in combat zones, for there is the risk of life from profound hemorrhage and of limb from inadequate circulation in cases in which a major vessel is involved.

One of the most urgent first aid measures is the arrest of hemorrhage from a large vessel by means of a tourniquet. If one is applied, it should be just tight enough to compress the artery but no tighter, and the time of its application should always be recorded on the record tag accompanying the patient. If it seems probable that the limb will have to be sacrificed it is best to apply the tourniquet close to the wound. In either event, the tourniquet should be released for a few minutes every hour and pressure over the wound applied while it is loose.

The experiences of Allen and Brooks on the survival of tissues deprived of their blood supply and refrigerated to 5 degrees C. have prompted the use of this cooling method in cases of major vascular injury. Holman suggests that, if practical, the packing of tour-

niquetted limbs in ice bags before and during transportation would permit the tourniquet to remain in place for 5 or 6 hours without harm to the tissues, and would reduce shock, provide comfort during transportation, and inhibit bacterial growth in the wound.

Direct control of the arterial bleeding by digital pressure is preferable if practical; it is generally adequate unless a major vessel is involved. If the main artery is divided, comparison of arterial pulse on the affected and on the normal limb will confirm the suspicion. An additional test to show the presence of collateral circulation is to make pressure on the main vessel distal to the injury and see whether any color remains in the tips of the extremity.

Additional measures to be taken are to heat the body but not the affected extremity; the latter may be protected from heat loss with woolen coverings. Treatment for shock is given as previously outlined. Injection of ½ grain of papaverine intravenously may be of value in overcoming vasospasm in the collateral blood vessels. Paravertebral block, if feasible, is a better method of attaining the same result.

Ligation of injured vessel. The vessel may be ligated directly in the wound itself after the wound is enlarged to gain adequate exposure; the débridement can be accomplished at the same time. If this is deemed to be impractical or too difficult, the vessel thought to be involved may be exposed far enough proximal to the point of injury to permit a clean dry field. Division between ligatures rather than ligation in continuity is preferable as it causes peripheral vasodilatation; companion veins should also be divided. If an artery is found to be thrombosed, the segment thrombosed should be excised, with the companion vein.

The following illustrations are useful to indicate the incision, the approach, and the collateral circulation in wounds of important arteries; also the dangers of ligation of arteries in continuity and the relatively greater danger of serious hemorrhage from a tangential wound of an artery than from one that completely severs it.

Arterial suture. The opportunities for successful suture of wounded arteries in combat zones are believed to be very few, the indications for and advantages of such attempts are highly problematical. Those interested in confirming these views should read the conclusions of Mitchiner based on cases of arterial repair by suture in the last war. Holman points out the need for ideal conditions when arterial suture is to be attempted: "absolute asepsis, proper instruments and facilities, and the availability of heparin continuously administered for 24 hours after operation." It is obvious that such ideal conditions seldom exist in zones of combat. Hence, double ligation of the vessel above and below the site of injury and division is the preferable method of controlling bleeding.

Other vascular injuries. Occasionally a wound close to but not directly injuring an artery has been associated with a localized segmental spasm of the artery. Both English and French writers have reported such cases calling them "concussion" or "stupeur" of the artery. This may disappear in 24 hours. Such wounds are débrided of surrounding traumatized tissue and a periarterial sympathectomy is done above and at the site of the spasm.

Contusion of an artery may cause subsequent thrombosis which may extend distally or liberate an embolus, and in either case be followed by massive gangrene. Or the contused area may be the site of a necrosis with secondary hemorrhage and if this is external through the wound may result in death of the patient. If it occurs internally a pulsating hematoma will be produced which may if not treated cause a sacculated aneurysm.

One of the rules in the official history of World War I reads: "when a large vessel is exposed in an open wound and has obviously suffered contusion and is thrombosed, the vessel should be ligated above and below the thrombosed segment and the latter excised. This eliminates the danger of embolism, of secondary hemorrhage, and vasoconstrictor influences affecting collateral circulation."

TREATMENT OF BURNS

This subject is of great importance since the nature of modern warfare, both on land and at sea, is such that severe burns are relatively common injuries. Impetus was given to the

work of the Subcommittee on Burns of the National Research Council by reason of intensive study of the cases received from the tragic Boston night club disaster. The recommendations of this committee for treatment of burns in the armed forces have been embodied in War Department Circular Letter 15 and circularized to every officer in the medical corps of the Army. An outline follows.

Fundamentals of treatment of burns:

1. Prevent and control shock.
2. Prevent infection; pyogenic, tetanus, gas gangrene.
3. Relieve pain.

The control of shock implies prompt and free use of plasma or, if available concentrated human serum albumin; if parenteral fluid replacement is required, 5 per cent glucose in sterile distilled water is used.

Chemotherapy in all moderate or severe burns should be given prophylactically and for this purpose sulfadiazene is the drug of choice; the initial dose is 4 grams. Thereafter maintenance dosage should be carefully decided by the medical officer with due regard for kidney damage due to the burn and the increased risk of renal complications of sulfonamide therapy.

Tetanus prophylaxis is indicated in cases of second or third degree burn.

Pain requires large doses of morphine and ordinarily ½ grain is required. If there is pronounced anoxia the dosage should not exceed ¼ grain.

Local measures—first aid treatment of burned area.

1. Since a burn is a large open wound and as such is subject to contamination by organisms from nose and throat, all personnel in the first aid room should be masked to minimize contamination from this source.
2. Burned surfaces should be covered with liberal amounts of sterile boric ointment or vaseline, followed by strips of fine mesh (bandage) gauze. Over this a smooth layer of sterile dressings (first aid dressings) should be firmly applied and pressure maintained by even bandaging with muslin, gauze, or some elastic type of bandage.
3. It is assumed that the administration of adequate amounts of plasma has been a first consideration.

Definitive treatment of burned area. This consists in the following:

1. Under regular operating room precautions to maintain asepsis, including masking of the patient all grease should be removed by ether, benzene, lard, or other detergents. The burned area and then the surrounding skin are to be cleansed with a bland nonirritating soap and water and soft cotton pledgets but no brushes. Tincture of green soap is not to be used.
2. Blisters should be removed as well as loose bits of epidermis. Skin that is obviously destroyed throughout its full thickness should be excised but if in doubt delay for several days is justified until it is obvious that damage to all layers is irreparable when excision can be done as a secondary procedure.

The wound can then be handled as any open surgical wound with primary skin grafting carried out if conditions are suitable. The measures outlined are usually painful and a general anesthetic is necessary; intravenous sodium pentothal is the anesthetic of choice.

3. Dressing of the wound involves the use of an ointment, i.e. boric ointment or vaseline, strips of gauze, and a thick smooth layer of sterile gauze, cotton, mechanic's waste or cellulose. The application of firm, evenly applied pressure is best accomplished by stockinet or some type of elastic roller bandage. Once applied the dressing should be left undisturbed for 10 days, barring complications. Emphasis is placed on the importance of firm pressure on burns involving the hands, feet, and face. It is desirable to use splints further to immobilize the affected parts.

The necessity for special nursing care for these burned patients is emphasized.

While skin grafting at as early a stage as possible is highly desirable it cannot always be done in the combat zone.

ABDOMINAL WOUNDS

It is an accepted principle that, because of the extremely unfavorable prognosis in patients with complicated abdominal injuries and because of the time consumed in operating upon them, it is not permissible to operate on such men to the exclusion of a greater number of less complicated casualties. Unlike the out-

come in wounds in other areas the majority of men with complicated abdominal wounds will not survive without early skilled operation and specialized after treatment. The introduction of sulfadiazene paste through the abdominal wound and the setting up of a blood drip to be continued in the plane or ambulance are considered by the British to be measures that may improve the patient's chances in case he must be transported. Patients operated upon for abdominal wounds should not be evacuated until they have had a chance to recover from the immediate effect of the operation and are clearly on the mend.

If conditions permit, wounded men presenting obvious or even suspected penetrating wounds of the abdomen should be subjected to laparotomy unless so extensive that intervention is clearly futile; an exception would be cases of simple penetrating wound of the liver in which nonoperative measures would be preferable.

Death following gunshot or other wounds of the abdomen results from shock, hemorrhage, and infection alone or in combination. Even in cases in which penetrating wounds of the abdomen are due to small sized missiles, the possibility of serious hemorrhage from blood vessel injury or gaping wounds of the intestine makes laparotomy advisable. A rectal examination and examination of the urine should never be overlooked and a radiographic examination which may reveal a foreign body or free gas in the peritoneal cavity should be made. Wounds of the upper abdomen require less prompt intervention than those of the lower abdomen; hemorrhage from penetrating wounds of spleen or liver which tend to be self-limited and perforation of the hollow viscera are less frequent than in wounds of the lower abdomen.

Treatment consists of the following:

1. Preoperative: Rapid, gentle transport with maintenance of body heat, relief of pain and shock, and administration of sulfonamides; catheterization if patient cannot void.

2. Operative: The choice of anesthesia is important and unless blood pressure is extremely low spinal analgesia is satisfactory. If used, however, circulation should be supported by concurrent transfusion of blood or plasma or glucose and saline infusion to counteract a further fall in blood pressure due to relaxation of the arterial bed. Control of bleeding points and inspection of organs for injury should be speedy but careful. Simple type of closure should be done; resection should not be resorted to unless conditions compel it.

When injuries to the intestines have been repaired and the peritoneal cavity has been soiled, complete rest of the alimentary canal by slow intravenous infusion and Wangensteen suction is almost indispensable. If the tube is introduced by the anesthetist before the abdomen is closed and its end is manipulated by the surgeon so as to be distal to the lowest repair in the bowel the effectiveness of the suction is enhanced.

The British accomplish gastric suction by use of a Ryle tube passed through the nostril and connected to an inverted vacoliter bottle filled with water and suspended above the bed. A second tube from the vacoliter leads to a water seal on the floor. By the use of a tube 4 feet long the upper coils of small intestines are kept decompressed.

Attention is again called to the fact that men with abdominal wounds withstand travel worse than do those with any other type of injury. Such casualties should be operated upon as far forward as it is possible to place an expert team and, after operation, they must not be moved to the base for from 4 to 10 days until they have recovered their equilibrium. The air evacuation of many patients in the earlier battles of the war in Africa, after relatively simple abdominal operations, resulted in death. Now the practice is to send a certain number of beds to each forward center for abdominal cases.

Time spent in resuscitation of patients with abdominal wounds generally lessens their chances; if there seems any prospect for survival the operation should be commenced as soon as a pint of blood has been given. During operation a blood drip can be administered.

No matter how trivial injuries to the large intestine are they must be exteriorized or drained. If the segment injured can be mobilized it should be resected and the ends brought out as a double barrelled colostomy. If it is

fixed the injury should be repaired and a proximal colostomy done. Any injury to the rectum also demands a proximal colostomy. The principle of exteriorization of colon injuries is certainly one of the most important advances of recent war surgery. The mortality rate has been greatly reduced, being around 50 per cent where it had been 70 to 90 per cent, depending on type of case.

In cases of considerable soiling a small tube, size of a No. 10 F catheter is put down to the site of greatest soiling and brought out through the incision. When the operation is completed 10 grains of sulfadiazine in 50 cubic centimeters of saline is injected slowly; the tube is then tied across and tucked into the dressings. On one or two subsequent occasions more drug is introduced if events seem to indicate it and the tube is finally withdrawn. The use of the Fowler's position, continuous gastric suction, and fluids by vein are essential in all cases having had intestinal tract injuries or peritoneal soiling.

CHEMOTHERAPY

Chemotherapy is one of the greatest single factors influencing the surgery of this war, but it is too broad a topic to consider in any detail here. The results of its use in the recent El Alamein battle are beginning to be known. All wounded were given sulfonamides by mouth from the time they reached the battalion aid post until they arrived at the base hospital. Of 1400 cases evacuated who were wounded in the first 12 hours and reached base hospitals within 36 hours without previous operation, only 46 required urgent treatment on arrival. There were only about 20 cases of anaerobic infection, only 2 or 3 of real gas gangrene.

The value of chemotherapy for war wounds in which there is already an established infection is questioned by many. In a recent trial of sulfasuxidine in the form of a 20 per cent paste in lanolin for such cases there are favorable reports of its effect on the infection. Certainly its theoretical advantages are obvious, namely, low rate of absorption, lack of toxicity and irritation and prolonged action. It also is effective against a variety of organism including the coliform group.

In abdominal cases in which sulfonamides have been instilled into the peritoneal cavity, there is no need for supplementary oral administration for 3 to 5 days. The urinary output should be kept between 1500 and 2000 cubic centimeters.

Packets of sterile sulfa compounds should be a part of every surgical set-up.

HEAD WOUNDS

A lesson learned by the English in their dealing with air raid casualties was that even minor scalp wounds should be explored for evidences of intracranial injury even though the patient's symptoms might never lead one to suspect a serious injury.

Scalp wounds without skull fracture should, if seen early, be débrided and closed with interrupted silk sutures; if closure is not practical the wound may be covered with vaseline gauze dressings after thorough cleansing and removal of dirt, hair, and foreign bodies.

Severe head wounds—those involving skull fracture with penetration of dura—require speedy evacuation to a hospital. A minimum of handling and great gentleness are desirable.

SPINE WOUNDS

Don't jackknife the patient—slide or roll onto the stretcher without lifting. Do not permit head to be rolled around or neck flexed in injuries to the cervical spine.

No débridement or suture of these wounds in the forward area is advisable. Such patients require immediate evacuation to a well equipped hospital. Speed in such transfer means prevention of a fatality or a permanent paraplegia.

PERIPHERAL NERVE WOUNDS

Injuries to peripheral nerves are chiefly of two forms: (a) those caused by a through and through bullet or shell fragment, and (b) wide lacerated wounds. The former require sterile dressing after the usual cleansing. The latter should have free irrigation with normal saline solution to rid wound of particles of dirt and foreign material.

Do not suture nerve wounds at time of injury as part of a primary débridement except in cases where it lies exposed in the wound and

time permits. Even under these conditions the wisdom of suture at time of débridement is open to argument. Certainly extensive dissection and immobilization of nerve ends to permit suture is never permissible. Procedures of such a nature should be carried out only in hospitals.

Immobilization of the involved extremity in the position causing least retraction of the nerve ends is desirable during transfer.

SUMMARY

1. Treatment of wounds in the combat zone follow the general principles that are accepted for surgery in times of peace.

2. Factors that alter the details of surgical treatment are those enforced by circumstances attendant upon conditions of warfare.

3. Shock, hemorrhage, resuscitation, wounds of soft parts, fractures, burns, vascular, chest, abdominal wounds, débridement and chemotherapy have been discussed briefly in relation to the general subject.

4. It seems obvious that the military surgeon in the combat zone must add to his qualities of courage and competence a resourcefulness and an ingenuity that will permit him to extemporize when necessary. He must be one to whom the urgency of a situation serves only as a challenge to meet it. He must not only know the truth of the saying "first things come first" but must be able to recognize which are the things of first importance. He must adopt the slogan and apply it to his own work: "The difficult we do immediately—The impossible takes a little longer."

SURVEY FILM DIAGNOSIS OF ACUTE SURGICAL ABDOMEN

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THE diagnosis of intra-abdominal surgical conditions may be baffling not only to the internist but to the surgeon as well. Clinical signs and physical findings are sometimes ill defined or absent, thus making a definite decision difficult in a questionable surgical abdomen. Considerable aid may be obtained from survey films or so called flat plates of the abdomen. A minimum of 3 films should be taken: a high and a low supine film and an upright film. In cases in which the patient's condition permits films in the prone and lateral decubitus positions are advantageous.

When a perforated viscus is suspected, an upright film is most informative (Fig. 1). Free air beneath the right leaflet of the diaphragm is pathognomonic of a ruptured viscus. The amount of air may be considerable or minimal, depending upon the size of the perforation and the rate of escape of gas. The greater the interval of time between the onset of symptoms and the roentgenoscopic examination, the greater the likelihood of positive findings and the larger the accumulation of air. When the differential diagnosis lies between a perforated peptic ulcer and a ruptured appendix, in the presence of a spreading peritonitis, one cannot say with any degree of finality whether it is one or the other, simply because there is free subdiaphragmatic air, since ruptured appendices and ruptured intestinal diverticula may also yield the same finding. It is fair to say, however, that ruptured peptic ulcers are much more often the etiological factor of free intraperitoneal air. One should emphasize the fact that when a patient is roentgenographed shortly after the onset of symptoms no *free* air may be seen, and the surgeon should be guided by clinical findings as to the handling of the case. If fluoroscopy is negative, an upright roentgenogram should be taken, since minimal collection of air may be seen on the film and missed on fluoroscopy. When the air collects beneath the left diaphragm it may be confused with the *magenblase;* to obviate this, a right decubitus film should be taken.

In obscure cases with abdominal symptoms in which coronary thrombosis must be differentiated as the underlying cause of the abdominal findings, an upright survey film is of great aid to the attending surgeon and is very often life saving.

Therapeutic pneumoperitoneum administered occasionally in tuberculous patients will confuse the issue when a surgical problem presents itself. After laporatomy *free* intraperitoneal air will persist for about 10 days and should be discounted in any given case. In hepatocolic interposition, a condition in which a loop of colon lies immediately subjacent to the right diaphragm, one should be extremely careful in the interpretation of the upright film. The presence of haustral markings will aid in differentiating this condition from free subdiaphragmatic air.

The diagnosis of intestinal obstruction is often made or corroborated by a survey x-ray film (Fig. 2). In small intestinal obstruction the loops assume a step-ladder appearance, are dilated, and very often present a hair pin turn. If there is marked small intestinal dilatation the involvement is most likely jejunal since more secretory activity occurs in the jejunum than in the ileum. The more proximal the intestinal obstruction, the greater the degree of intestinal dilatation. It is usually abnormal to find gas within the small bowel, so that *a priori*, when clinical signs of obstruction are present, this finding should be regarded with suspicion. Trapped gas in one isolated loop of small bowel may be the earliest manifestation of obstruction and one is cautioned not to delay treatment until all the diagnostic criteria are present for that may spell disaster to the patient. The presence of a fluid level in the upright film is an additional valuable sign of obstruction; however, considerable difficulty may be experienced in obtaining satisfactory upright films in ill patients. Gas in intestinal obstruction may be due to

From the Surgical and X-ray Departments, Jewish Hospital.

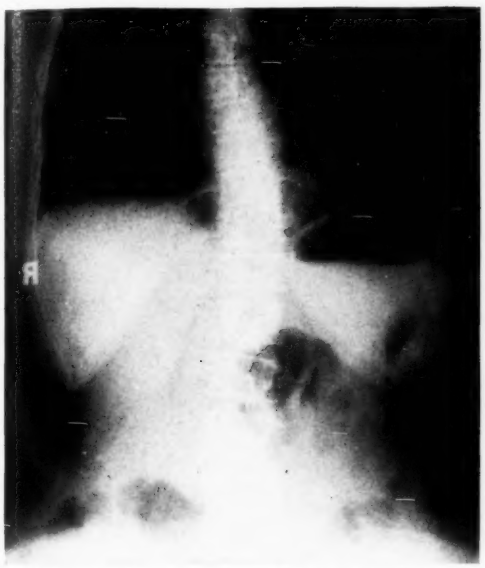

Fig. 1. In this roentgenogram is shown a small collection of air beneath the right diaphragm due to perforated duodenal ulcer.

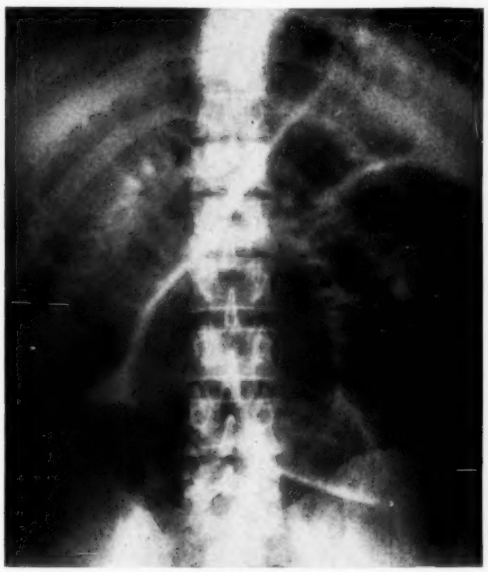

Fig. 2. Typical fully developed small intestinal obstruction with characteristic step-ladder appearance. Dilatation involves jejunum. Note prominent valvulae conniventes.

ingestion diffusion through the bowel wall and putrefaction. Ingested air may traverse the small bowel in 6 to 15 minutes.

It is often rather hard to distinguish between small and large intestinal loops, and a posteroanterior film may be very helpful. The small intestinal loops are diffusely located throughout the abdomen, whereas the colon has more of a peripheral distribution. Definite identification of haustrations indicates colonic involvement, but one must be careful not to confuse these with pseudohaustrations seen in dilated small intestinal loops.

The presence of gas in both the small and large bowel bespeaks either an obstruction that has released itself or a partial obstruction. A similar appearance may be produced by morphinization. Morphine (1) affects the duodenum greatly; the duodenum is first constricted and then dilated. In susceptible individuals one repeatedly observes accumulation of gas in both the large and the small bowel. To discount the effect of postoperative morphinization the drug should be withdrawn and the patient again roentgenographed for any change in the intestinal gas pattern. Ordinarily (2) the ileocecal valve blocks the egress of gas from the small into the large bowel. In sigmoidal obstruction of long standing there may be regurgitation of air into the cecum with marked distention or even rupture of the cecum (Fig. 3). Tremendous dilatation of the cecum on survey films should arouse the sus-

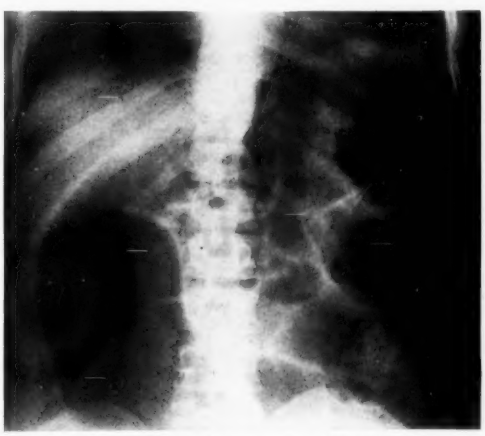

Fig. 3. Markedly dilated cecum produced by obstructing carcinoma of rectosigmoid.

Fig. 4. Right subdiaphragmatic abscess. Fluid level within abscess cavity.

Fig. 5. Subhepatic abscess displacing duodenal cap to the left and the hepatic flexure downward.

Fig. 6. Acute intussusception. Note telescoping of bowel into the transverse colon resulting in double column of colonic gas. Loops of cecum and ascending colon are absent from usual habitat.

picion of a low colonic obstruction (Fig. 4). If a subdiaphragmatic abscess is suspected it is imperative to make upright, supine, and prone films with the Bucky diaphragm, and also lateral decubitus films. In a well defined abscess there is a fluid level seen only in the upright position. A lateral view is necessary for more precise localization, to aid the surgeon in the proper surgical approach to the lesion. Upon fluoroscopic examination, if elevation of the diaphragm and restricted excursion combined with pleural effusion or basal pneumonitis are seen, it is cause for increased suspicion (Fig. 5). Subhepatic abscess may be suspected when there is a dense shadow confluent with the lower border of the right lobe of the liver, displacing the stomach and duodenum to the left, and the hepatic flexure downward.

Perinephric abscess may be suspected when there is obliteration of the ileopsoas line, a scoliosis of the lumbar column away from the affected side, an indistinct kidney image, and a restriction in the upright posture of normal kidney mobility. Often there is a bellying of the psoas mass, and this finding should not be ignored but reported.

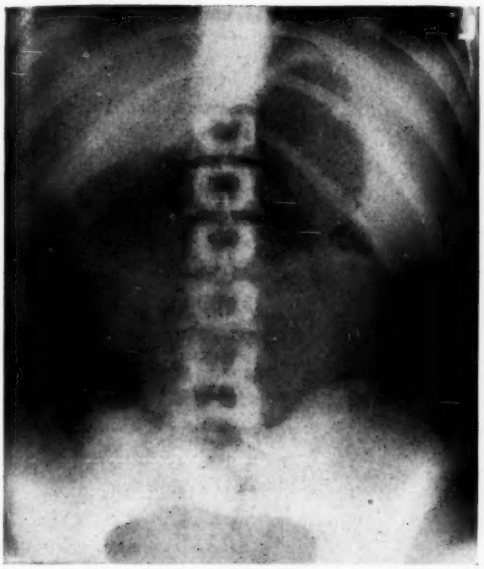

Fig. 7. Lacerated spleen. Markedly serrated greater curvature of cardia of stomach. Widened gastrocolic omental space due to hemorrhagic infiltration.

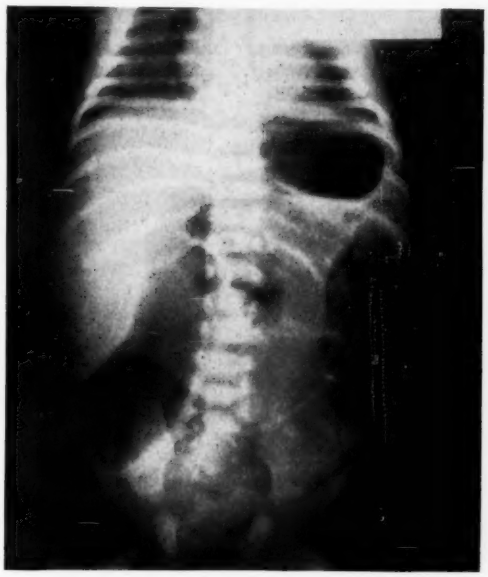

Fig. 8. Volvulus. Markedly dilated loop of sigmoid ascending to right upper quadrant. Note reduplication of colonic loops.

A pelvic abscess may offer diagnostic criteria by the presence of a homogeneous opacity in the region of the pelvis coupled with an upper abdominal ileus. Depending on the size of the abscess, upward degrees of displacement of loops of bowel are observed. Roentgenologically pelvic abscess must be differentiated from ovarian, uterine, and retroperitoneal tumors. The latter are usually more sharply defined and circumscribed than in pelvic inflammatory disease. An ovarian dermoid reveals itself through the presence of calcifications, teeth, and fluid levels of varying densities.

Intussusception yields the usual x-ray findings of intestinal obstruction, and often one may actually visualize the intussusceptum and the intussuscipiens (Fig. 6). We have observed in several cases the telescoping of the bowel loops, usually the ileum within the ascending colon or transverse colon. As the intussusception develops there is a paucity of small intestinal loops away from the site of the lesion. In cases of subacute intussusception with spontaneous reduction we note an ever

Fig. 9. Gastrectasis due to tuberculous adenitis. Dilated stomach occupying greater part of the abdominal cavity. Caused by complete duodenal obstruction due to retroperitoneal tuberculous glands.

Fig. 10. Abdominal aortic aneurysm. Clinically it simulated an acute visceral surgical abdomen; ruled out by scout films. Calcified rim at periphery of aneurysm.

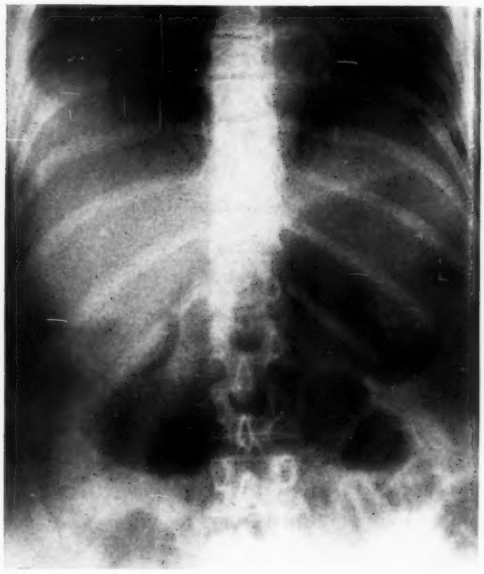

Fig. 11. Ruptured ulcer in retroperitoneal portion of the duodenum. Note crescentic collection of air about duodenal cap.

changing picture as the obstruction appears and disappears.

Survey film examination is very helpful in traumatic cases. In a great many normal subjects examination delineates the splenic shadow in the left upper quadrant (Fig. 7). It is sharply defined against the outline of the adjacent stomach, especially when the latter is filled with gas. In a lacerated spleen, the blood gravitates along the gastrolienal ligament between the folds of the gastrocolic omentum; this may produce one or several of the following helpful hints toward arriving at a precise diagnosis. The greater curvature of the stomach assumes a serrated appearance because of the juxtaposition of the adjacent hematoma. The stomach is displaced to the left and the transverse colon downward.

There is an increase in the size of the splenic shadow especially in cases of intracapsular splenic hemorrhage. The splenic shadow usually merges with the opacity extending into the region of the gastrocolic omentum resulting in further separation of the two air distended hollow viscera. In case of shock following lacerated spleen, gastrectasis is an associated finding, the stomach ballooning out with a large amount of air.

Lacerated livers are characterized by splinting of the right diaphragm on respiration, enlargement of the hepatic shadow, an ill defined lower hepatic border, and a displacement of the stomach to the left, when the right lobe of the liver is lacerated.

Mesenteric thrombosis yields a picture similar to that of ileus. In the majority of our cases the small intestinal loops have been only slightly dilated and the degree of intestinal dilatation has been less marked than in obstructive lesions. Mesenteric abscess produces a homogeneous radio-opaque shadow within the peritoneal cavity, surrounded by dilated small intestinal loops.

Occasionally small intestinal obstruction in the elderly patient is due to a gall stone which has entered the small intestine via a cholecystointestinal fistula. A survey film reveals the usual x-ray signs of obstruction plus the presence of a calculus within the small intestine. Therefore, the film enables one not only

to make a precise etiological diagnosis but also to localize the site of obstruction. An additional clue to cholecystointestinal fistula is the presence of striated air shadows within the biliary ducts. These may be disseminated over the entire liver or may constitute only a few isolated streaks over the right lobe of the liver.

Volvulus, a rare condition, has been diagnosed by us several times on the basis of survey x-ray films (Fig. 8). Usually one finds markedly dilated loops of large intestine particularly near the hepatic flexure. Since volvulus is invariably associated with considerable elongation and reduplication of the sigmoid, which often ascends diagonally to the right subhepatic region before making a downward swoop, one finds on careful analysis of the film multiple vertical loops of large intestine in the normal habitat of the ascending colon. Extreme degrees of large intestinal dilatation are seen in volvulus. Dilated loops of small intestine having an arcade arrangement suggest a small intestinal mesenteric volvulus, rotated about an adhesive band.

In tuberculous adenitis, one may encounter on occasions complete duodenal obstruction resulting in marked gastrectasis (Fig. 9). In one of our cases retroperitoneal tuberculous glands caused complete duodenal obstruction because of periduodenal adhesions. The stomach was huge, occupying practically the entire peritoneal cavity simulating a pneumoperitoneum. The patient died rapidly in severe alkalosis (Fig. 10). A ruptured abdominal aneurysm may simulate an acute surgical abdomen. The survey film shows a diffuse homogeneous density to the left of the lumbar spine obliterating the left ileopsoas line. Very often one notes either calcific débris within the mass or fine arteriosclerotic plaques within the wall of the aneurysm.

On several occasions not only a false diagnosis of some intraperitoneal surgical condition was avoided but also a useless operation.

While an extended discussion of intra-abdominal intestinal lesions in the newborn cannot be undertaken here, a few words may be helpful. Congenital small intestinal anomaly may be suspected by the presence of large amounts of small intestinal gas. In two of the infants there was marked distention of the cecum and ascending colon due to congenital bands extending from the right lobe of the liver and constricting the right half of the transverse colon. Complete or partial intestinal atresia may be suspected from a survey x-ray film. In atresia of the sphincter ani, it may be advantageous to examine the baby in complete Trendelenburg position; one notes distention of the large bowel including the rectal ampulla, the column of air stopping short of the anus (Fig. 11).

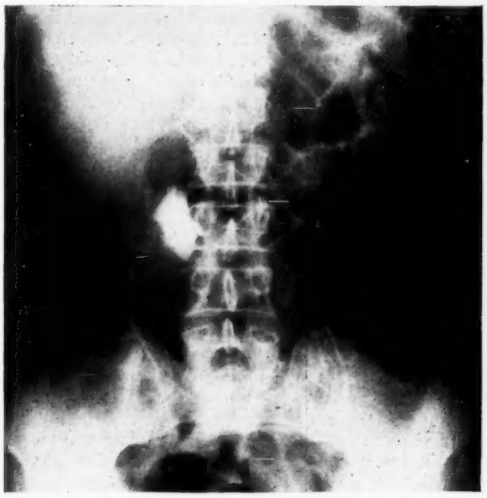

Fig. 12. Reflex ileus secondary to acute cholelithiasis. Spontaneous recession after cholecystectomy.

CONCLUSION

Survey x-ray films of the abdomen are very helpful in arriving at a diagnosis in intra-abdominal surgical conditions. In spite of diagnostic limitations, these films very often aid in arriving at a precise conclusion in baffling cases.

CASE 1. Baby girl T. was delivered normally, uneventfully, and spontaneously, 48 hours before onset of symptoms. On January 14, 1940, the infant vomited greenish material, the abdomen was distended, and colonic irrigation resulted in passage of meconium and reddish black material. Physical examination revealed moderate distention, with soft coils of intestine discernible at times. Peristalsis was hyperactive. Survey film of the abdomen showed marked small intestinal distention. A suggestion of

a stepladder appearance corroborated the clinical diagnosis of intestinal obstruction and indicated that we were dealing with a small intestinal anomaly. At operation a complete atresia of the jejunum was noted. Enteroenterostomy was done, but the child died 3 days after operation. Postmortem examination revealed again congenital atresia of the jejunum, a patent midline duct, low grade peritonitis, and adrenal hemorrhage.

CASE 2. K. M., a middle aged woman complained of severe lower abdominal pain. Physical examination revealed a considerable amount of tenderness and some rigidity in the hypogastric region. Peristalsis was normally active. Auscultation revealed a bruit. Survey film of the abdomen showed a large aneurysmal dilatation of the lower end of the abdominal aorta. Thus we were able to make a precise diagnosis. The survey film in this instance obviated an unnecessary intra-abdominal operation.

CASE 3. R. C., aged 57 years, was admitted to the hospital December 11, 1942. The diagnosis then was intestinal obstruction. Patient complained chiefly of pain in the right upper and right lower quadrant. On December 9, patient awoke with pain, increasingly severe and constant. She had not had a bowel movement since December 8; she had complained of chronic constipation for months and, for the past 3 days, of loss of appetite and vomiting. Physical examination showed considerable rigidity and tenderness in the right upper quadrant. There was a moderate degree of distention, and a soft palpable mass was elicited in the right upper quadrant. The blood count showed a moderate leucocytosis: white blood cells, 13,800; polymorphonuclears, 88; van den Bergh showed direct, negative, and indirect 1.6 milligrams. Survey film of the abdomen showed a large amount of small intestinal distention. There were numerous small intestinal coils in the left abdomen. In addition to that, there was a large radio-opaque stone on a level with the fourth lumbar vertebra. This was strongly suggestive of a gall stone. At operation on December 11, a large stone in the gall bladder as well as an acute cholecystitis was revealed (Fig. 12). Patient was discharged December 24, in good condition.

CASE 4. L. K., boy aged 16 years, complained of intermittent colic-like abdominal pain. Physical examination revealed in the epigastrium a mass which would appear and disappear. Symptoms were most pronounced at the time the mass was palpable. There was no evidence of bloody stools or diarrhea. Survey film of the abdomen revealed evidence of intussusception. There were a number of distended loops of small bowel, in the left portion of the peritoneal cavity. In the right side of the peritoneal cavity there were practically no intestinal loops. Careful examination of the survey film showed evidence of an intussusceptum and intussuscipiens in the right upper quadrant. We noted a double column of air within the small bowel, one of the loops of the bowel being telescoped into an adjacent loop. The diagnosis was intussusception. At the time of operation the surgeon found intussusception caused by a lymphosarcoma at the terminal ileum. A resection with ileocolostomy was done. Patient made an uneventful recovery. Microscopic examination revealed lymphosarcoma of the ileum. Patient is alive and well 6 years after operation.

Interesting feature of this case was the appearance of secondary metastasis in the humerus about 18 months subsequent to operation. Changes in the humerus responded very nicely to radiation.

CASE 5. H. P. H., aged 41 years, was admitted to the hospital December 15, 1942. His chief complaint was pain in both testes, the loin and in the epigastrium. The pain began a day prior to admission, and had increased in severity. There was moderate abdominal distention. The patient vomited twice prior to admission. He had had no bowel movement for 7 days. This portion of the history was rather unreliable as the patient was a vagabond and homeless. Physical examination showed a moderately distended abdomen; on palpation there was tenderness in both loins. There were no palpable masses. Peristalsis was present. The clinical diagnosis was possible intestinal obstruction. The precise cause of the intestinal obstruction could not be determined. A survey film of the abdomen showed a diffuse, large intestinal distention. The sigmoid particularly was elongated and could be followed to the right upper quadrant. There was marked reduplication of the sigmoid. A pre-operative diagnosis of volvulus was made, and this diagnosis was corroborated at operation.

The obstructed loop of sigmoid was resected; a Mikulicz operation was done. Patient made a satisfactory recovery.

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FRESH FRACTURES OF THE CARPAL SCAPHOID

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FRACTURES of the carpal scaphoid occur almost exclusively in vigorous young adult males. They are rarely seen in older persons or in women of any age. It is not surprising, therefore, to find a large number of these fractures in an army training camp. This report is based on a study of 45 consecutive carpal scaphoid fractures which occurred in an infantry training camp during an 18 month period.

ANATOMY OF THE CARPAL SCAPHOID

The scaphoid bone has anatomical peculiarities which have a direct bearing on the incidence and healing of these fractures. It is the largest bone in the proximal row of the wrist and is elongated in shape. The mid portion of the bone is somewhat constricted and is known as the "waist." It is at this constricted mid portion that most of the fractures occur.

Freed of its soft tissue attachments the scaphoid is found to be almost entirely smooth. Most of its surface consists of articular cartilage, for it articulates with five bones; the radius, lunate, greater multiangular, lesser multiangular, and capitate. There is a narrow ridge running obliquely around the dorsal surface from the tuberosity on the lateral side to the proximal base medially. In this ridge are found the arterial foramina, and it is through these apertures that the bone receives its blood supply.

Obletz and Halbstein studied the blood supply of 297 carpal scaphoids and found that every specimen had at least a few arterial foramina in the tubercle and distal portion. In 67 per cent of the bones there were arterial foramina along the entire length of the bone adequately supplying both the proximal and distal portions. In 13 per cent there were no arterial foramina proximal to the waist. They concluded that a fracture through the waist of the bone could interrupt the blood supply to the proximal fragment in between 13 and 33 per cent of the cases (Fig. 1).

MECHANISM OF FRACTURE

In most instances the soldiers report that they fall or are thrown to the ground, and in attempting to break the fall land on their outstretched hands, occasionally on the backs of ther hands. Usually the heel of the palm is the first to strike the ground. There is a jarring impact as the wrist receives the shock, but the wrist does not hyperextend, for it is rigidly fixed by the soldier's strong forearm muscles. This impact cracks the scaphoid bone at its mechanically weak point, the waist. Of the 45 fractures, 35 were through the waist. Except for the scaphoid all the carpal bones are roughly cuboid in shape and have no weak points. The impact which cracks the slender scaphoid waist is apparently not sufficient to fracture any of the other carpal bones. Such fractures are quite rare.

In support of this explanation for the mechanism of fracture is the high incidence of hair line fracture shadows and more distinct fracture lines through the waist, without anatomical displacement of the fragments. Of 45, all but 3 showed absolutely no displacement of the two portions of the scaphoid. It would seem that any element of hyperextension of the wrist would separate the two fragments after the fracture.

This mechanism of fracture also explains the puzzling greater incidence of scaphoid fractures than Colles fractures in vigorous male adults. During the same period of study there were only 10 typical Colles fractures among the soldiers in training. In civilian life the relative frequency of Colles fracture to scaphoid fracture is given as 10 to 1 by Scudder. The strong wrist of a soldier does not hyperextend when he falls on his hand but the scaphoid may crack. The weak wrist of a woman, a sedentary worker, or older person hyperextends under the same conditions and a Colles fracture often results.

CLINICAL SYMPTOMS AND SIGNS

In a typical instance, when a soldier falls on his palm and feels pain in his wrist, he reports to his dispensary. The medical officer examines his wrist, sees little or no swelling, finds a tender point in the anatomical snuff-box, and elicits pain on passive motion of the wrist in all planes. Active and passive motions are restricted because of pain. The soldier thus presenting these clinical evidences of a fracture of the scaphoid bone is referred to the x-ray department for roentgenologic examination.

ROENTGENOLOGY

The roentgenograms are taken of the wrist in

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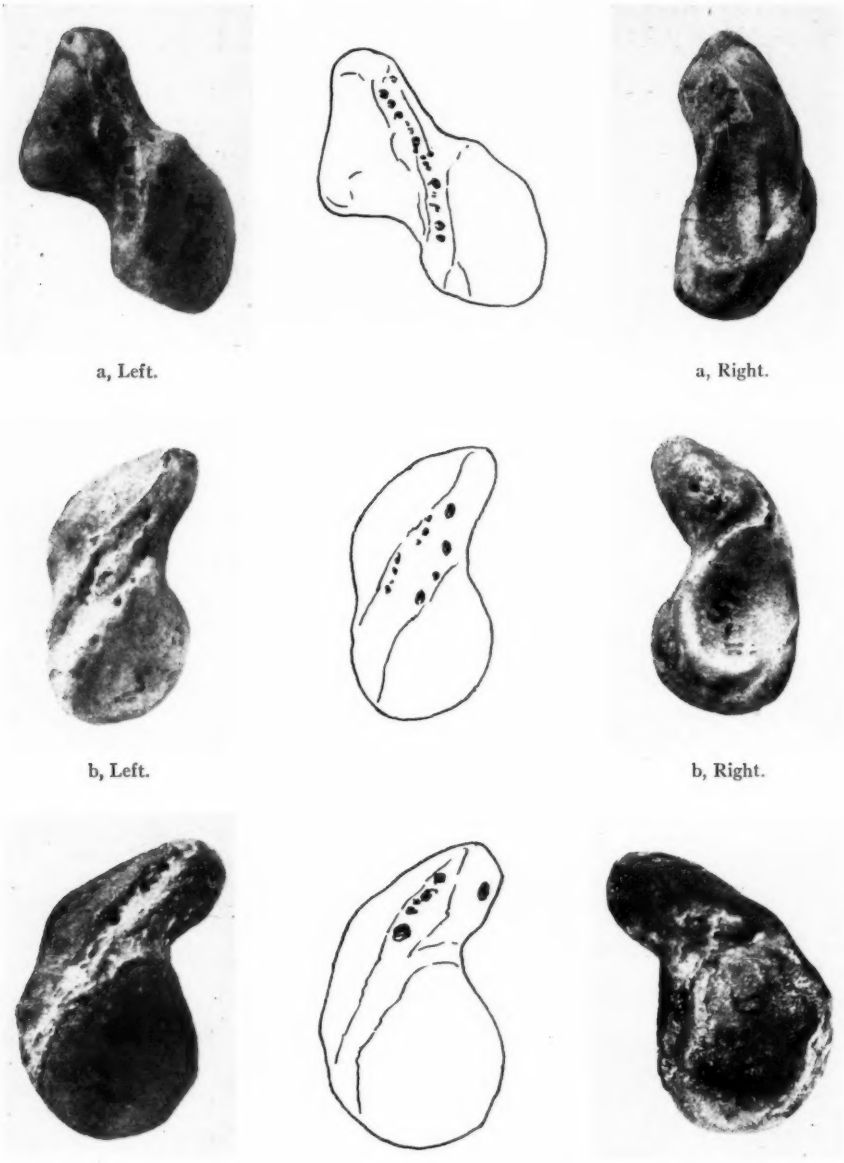
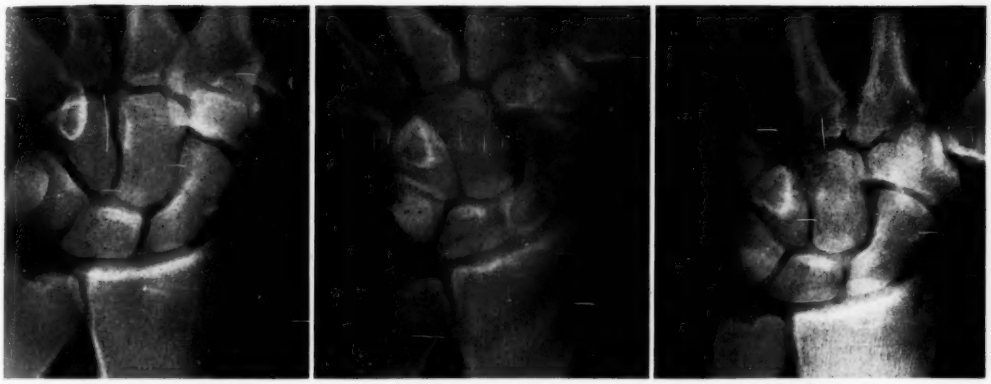


a, Left. a, Right.

b, Left. b, Right.

c, Left. c, Right.

Fig. 1. a, The entire length of the scaphoid is adequately supplied by arterial foramina in 67 per cent of the bones studied by Obletz and Halbstein. A fracture through any portion of the scaphoid does not interrupt the circulation to either fragment. Type I fracture. b, In 20 per cent of the scaphoids a fracture through the waist may or may not interrupt the blood supply to the proximal fragment. Type I or type II fractures. c, In 13 per cent if there is no arterial foramen at the waist or proximal to it, a fracture will interrupt the blood supply to the proximal fragment. Type II fracture. (Courtesy *Journal Bone & Joint Surgery.*)



a, December 17, 1942 b, February 12, 1943 c, March 17, 1943

Fig. 2. J. T. C. Type I fracture. The hairline fracture through the waist, a, does not interrupt the blood supply to the proximal fragment. There is mild hyperemic decalcification equally involving both halves of the scaphoid at 8 weeks, b. The fracture line is completely obliterated 12 weeks after the injury, c.

four positions on a 10 by 12 film. The usual anteroposterior and lateral views are supplemented by one anteroposterior view in ulnar deviation and a posteroanterior view in 45 degree oblique. Using this four-view technique not even the finest hair-line fracture should escape detection. Previous to the routine use of this technique there were several instances in which the standard anteroposterior and lateral views disclosed no fracture, only to have repeated examination at a later date reveal a fracture line which had been missed.

The fracture healing of the carpal scaphoid can be followed by serial roentgenograms. Once the fracture is recognized in the four-view film the repair process can best be studied in the single ulnar deviation view repeated at 3 to 4 week intervals. For each examination the plaster cast is removed and a new one applied if the x-ray shows the need for further immobilization. To show the healing process the films must be technically satisfactory. In general it has been found better to overexpose somewhat than to underexpose the negative. An underexposed film does not show small but important differences in densities.

Of the 34 fractures studied, 35 were through the waist of the bone, while 10 were through the proximal pole. There were no fractures of the tubercle found in the series studied.

FRACTURE PHYSIOLOGY

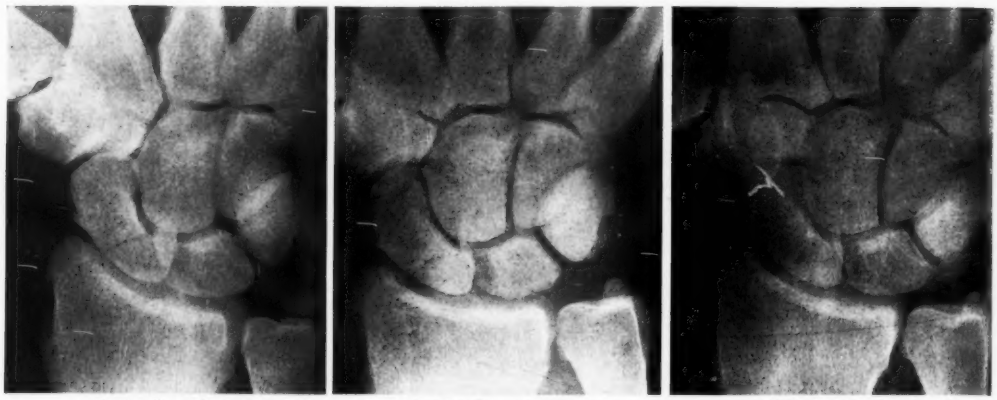
There are several features of the repair of fractures which are particularly applicable to fractures of the scaphoid.

Stirling has shown that during the first 2 weeks fluids taken from fracture sites shows a drop in *p*H from 7.4 to 4.8 on the 4th day, with a return to normal alkalinity on the 11th day. This acidity brings about a localized absorption of calcium salts at the fracture site, causing the fracture line to be wider and more distinct on the roentgenogram taken a few weeks after fracture.

Also during the first few weeks there is a reactionary hyperemia which is initiated by the fracture. This active hyperemia is believed to be caused by the liberation of minute quantities of histamine and acetylcholine at the site of the fracture. As a result of this hyperemia the bones of the wrist undergo decalcification and osteoporosis (Greig, Watson-Jones and Roberts, 14). This decalcification is usually mild but occasionally may be severe. The hyperemia subsides normally within 2 weeks, after which time there is a slow return of calcium to the involved bones. The process of recalcification is retarded by the fact that the wrist is immobilized in a cast and ordinarily undergoes disuse atrophy. For this reason the return of normal density to the wrist as seen on the roentgenogram may be delayed until the fracture is completely healed and active use of the wrist is restored.

In those wrists which are not completely immobilized, the repeated trauma at the fracture site causes the hyperemia to be prolonged beyond the usual 2 week period. Consequently the decalcification is more pronounced and the return to normal roentgenographic density is delayed.

The phenomena of hyperemia producing decalcification is dependent upon adequate blood



a, September 16, 1942 b, October 30, 1942 c, December 4, 1942

d, April 26, 1943

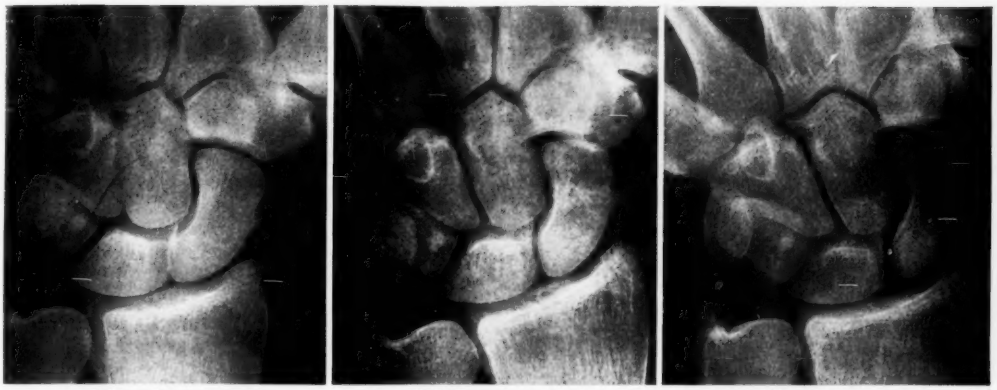
Fig. 3. B. K. Type II fracture. On the day of injury the hairline fracture is seen through the proximal pole, a. Six weeks later there is a contrasting density between the avascular proximal pole and the surrounding bones, b. This is evidence of interruption of circulation to the proximal fragment. Eleven weeks after the injury the fracture line is barely visible and there is less contrast between the two fragments of the scaphoid, c. The final study 26 weeks after the injury shows the fracture to be completely healed. There is uniform density in the entire scaphoid, d.

supply to the involved bones. If the arterial supply to a bone or portion of a bone is interrupted during the phase of hyperemia, that portion does not decalcify along with the neighboring bones but retains its normal calcium content and its normal radiologic density. This is roentgenographic evidence of avascularity. Steindler believes that the most important factor in the production of nonunion is interference with the nutrient arterial system of the bone.

Johnson has shown that bone repair occurs in the scaphoid in the same way as in the medulla of the diaphysis, but that all bones of this cancellous type heal more slowly than long bones. "This is largely due to the lack of subperiosteal callus formation but is also due in part to the cancellous reaction being less extensive and less active than is the medullary response in the diaphysis."

In the absence of callus formation as a criterion of healing of a fracture, we must rely solely on the radiographic disappearance of the fracture line as evidence of union of the fractured scaphoid. A persisting fracture line beyond 10 to 12 weeks is indicative of delayed union.

If the wrist is not immobilized adequately, the continued movement causes a shearing stress between the two fragments of the fractured scaphoid. Under the influence of this shearing and gliding motion fibrous and fibrocartilaginous tissue develop at the fracture site. The bone immediately underlying the new-formed cartilaginous layer becomes sclerotic and eburnated and assumes many of the characteristics of subchondral bone. On the roentgenogram this condition is recognized by the persistent translucent fracture line with a dense white irregular sclerotic



a, December 21, 1942 b, February 2, 1943 c, May 18, 1943

Fig. 4. J. W. C. Type II fracture. The fracture is through the waist, a. At 9 weeks the fracture line demarcates the distal porotic fragment from the dense avascular proximal fragment which does not enter into the hyperemic decalcification initiated by the fracture, b. The final study 23 weeks after the injury shows the fracture line to be completely obliterated. The densities of the two portions of the scaphoid are blending, c.

margin on either side of the line dividing the cancellous bone of the scaphoid into two parts. This picture indicates nonunion of the fracture.

TYPES OF SCAPHOID FRACTURES

Based on our knowledge of the anatomical variations in blood supply and our understanding of the physiology of fracture repair, together with a careful study of serial roentgenograms taken 3 to 4 weeks apart, we are able to divide our 45 fractured scaphoids into two groups: type I—fractures without interruption of the blood supply to either fragment; type II—fractures with interruption of the blood supply to the proximal fragment.

As would be expected from the anatomical studies, the majority of the fractures fall into the type I group, inasmuch as two-thirds of the scaphoids have an adequate distribution of arterial foramina throughout the long axis of the bone.

At the first x-ray examination on the day of injury the fracture line is barely visible in many cases. The fracture line at the waist is either a hair-line fissure or a more easily recognizable crack. There is usually no displacement of one fragment on the other. In 4 cases the displacement is barely perceptible. The entire scaphoid bone and the surrounding wrist bones show a uniform normal density on the film. In one case there was an associated injury to the radius, consisting of a transverse crack fracture 1 inch from the distal end without any displacement. In another case there was an associated Bennett's fracture-dislocation of the first metacarpal.

At the roentgenographic examination made 3 or 4 weeks after the injury the fracture line is seen to be more distinct than the hairline shadow seen on the day of injury. There is mild to moderate diffuse homogeneous decalcification of the cancellous bones of the carpus *including both fragments of the scaphoid* to an equal degree.

At the examination made at 6 to 8 weeks there is noted a partial or even complete obliteration of the fracture line. In many cases the fracture appeared to be healed within 8 weeks. The decalcification process has stopped and there is evidence that some recalcification has occurred, although the entire carpus is less dense than the normal wrist taken for comparison. Both portions of the scaphoid maintain a density uniform with the surrounding bones.

If the fracture line has disappeared and the cast is removed, a subsequent roentgenogram 4 weeks later shows restoration of the normal density to all the bones of the wrist including the newly-healed scaphoid (Fig. 2).

There were 8 fractures of the scaphoid in the type II group, showing interruption of blood supply to the proximal fragment. On the first day of the fracture the cases in this group appear identical with those of type I. At the second examination made at 3 or 4 weeks, the fracture line is more distinct due to the local resorption of calcium at the fracture site. There is evidence of generalized decalcification in all the bones *except the proximal fragment of the fractured scaphoid.* This fragment shows the same density as it did on the day of the fracture. The fracture through

the waist has interrupted the blood supply to the proximal fragment, thus excluding it from the reactive hyperemic decalcification. This difference in density between the proximal fragment and the distal may not be obvious unless the degree of decalcification is sufficient to afford a contrast.

At 6 to 8 weeks the generalized osteoporosis of the carpus is usually more pronounced than in the the type I cases. There is no difficulty at this time in recognizing the difference in density between the proximal fragment and the surrounding bones. The proximal fragment has retained its original calcium and original density, and stands out in sharp contrast to the osteoporosis of the adjacent bones. The fracture line is still visible. At 10 to 12 weeks the fracture line shows signs of healing but there is still a noticeable difference in density between the proximal fragment of the scaphoid and the neighboring bones. There may be evidence of beginning restoration of calcium to the carpus.

At 16 to 20 weeks the fracture line has been obliterated by the healing process. The difference in density between the two parts of the scaphoid is less marked. Their densities seem to blend. If the cast is now removed there will be a return of normal bone density to the carpus within a few weeks. Subsequent examinations fail to reveal degenerative changes in the scaphoid. At no time can the mottled density of "creeping substitution" be demonstrated in the proximal fragment (Figs. 3 and 4).

CONCEPT OF TEMPORARY AVASCULARITY

It is very important to distinguish between temporary avascularity of the proximal fragment and aseptic necrosis of this part. The dense white shadow cast by the proximal fragment of the fractured scaphoid in type II cases is evidence of avascularity but not of necrosis. According to Brailsford, "temporary retention of calcium by a fragment of bone does not indicate that the fragment is necrotic; it may fuse without any of the secondary changes characteristic of necrotic bone."

Experimental studies have shown that bone cells die slowly when deprived of their blood supply. Phemister (6) has shown that some bone cells in a free bone transplant appear to be alive for as long as 1 month. It is very likely that the bone cells in the proximal fragment of the fractured scaphoid do not immediately become necrotic after the interruption of blood supply. If revascularized within a reasonably short time, perhaps 3 weeks, this fragment can remain viable.

This concept of *temporary avascularity* is demonstrated in the type II fracture. Immediately after the fracture is immobilized the healing process begins. Fibrous granulations grow across the fracture site, bringing new blood vessels from the distal to the proximal fragment. This process is fairly rapid and within a few weeks the blood supply is more or less completely restored, in this manner preventing necrosis of the proximal fragment.

At this stage the roentgenogram shows the proximal fragment to have the same density as is seen on the day of injury. It is impossible to tell without microscopic study whether this fragment is viable or necrotic. The rapid restoration of the blood supply to the avascular fragment is not manifested on the roentgenogram for it does not immediately cause a decrease in density. Bone loses its calcium when under the influence of active hyperemia but this phase of hyperemic decalcification has already subsided by the time the proximal fragment is revascularized. Hence the difference in density between the two portions of the scaphoid persists for several months despite the fact that both fragments are viable and have adequate blood supply. As the carpus recalcifies there is a gradual blending of densities until there is no visible contrast between the two portions of the scaphoid.

Temporary avascularity of the proximal portion may lead to aseptic necrosis if the revascularization process is inadequate or disrupted. In the event that the wrist is not adequately immobilized, the shearing movements at the fracture site prevent the growth of new blood channels into the proximal fragment. The fibrocartilage at the fracture site forms an effective barrier to isolate the proximal fragment from its only source of blood supply. The proximal fragment slowly dies. This is shown in Phemister's case (7) of a nonunion of a waist fracture of a carpal scaphoid which showed a dense proximal half contrasting sharply with the osteoporotic viable distal half and neighboring bones. The proximal half was removed 93 days after the fracture and was found to be necrotic on histological examination.

CLINICAL SIGNIFICANCE OF TEMPORARY AVASCULARITY

Many surgeons have advocated early removal of the proximal portion in fractures of the carpal scaphoid. Watson-Jones (13) in his excellent treatise on these fractures believes that only early excision of the proximal fragment which shows a complete loss of blood supply can succeed in pre-

venting degenerative arthritis of the wrist. He says that "diagnosis is usually possible within a few weeks of injury and operation should be undertaken at once." Phemister (7) says that "if the necrotic fragment is not removed it may undergo slow creeping substitution, or the interior may be absorbed but not replaced by bone, giving a honeycombed appearance in the roentgenogram. Adhesions, partial necrosis of cartilage, irregularity of articular surface, and chronic arthritis are frequent late results."

The series of roentgenograms in the type II fractures shows that healing does occur in fractured carpal scaphoids despite temporary avascularity, provided the wrist is adequately immobilized. Healing is somewhat delayed. Drilling of fragments and bone grafts as advocated by some surgeons (4, 8, 10) are not necessary. Excision should be performed only when there is positive x-ray evidence of nonunion of the fracture and aseptic necrosis of the proximal fragment as seen by creeping substitution with its irregular mottled density and partial collapse.

TREATMENT

From the foregoing discussion of the healing of fractures of the carpal scaphoid it is evident and imperative that the wrist be immobilized as soon as possible after the fracture. The immobilization must be complete, uninterrupted, and maintained until there is definite x-ray evidence of healing.

In our experience a plaster-of-Paris gauntlet as described by Soto-Hall and Haldeman is the most satisfactory method of giving complete immobilization. The circular cast extends from the distal palmar crease to the elbow and includes the proximal phalanx of the thumb. The wrist is fixed in a few degrees of dorsiflexion and the thumb is maintained in a neutral relaxed position. In this type of cast the fingers can be flexed into the palm and the index finger can touch the tip of the thumb. The soldier is not hospitalized but is encouraged to use his hand as much as possible and to participate in the training program of his group (Fig. 5).

The cast is replaced as soon as it breaks or softens or otherwise fails completely to immobilize the wrist. This is very important during the first month when the fracture repair process is delicate and requires complete protection from shearing stresses. At 3 to 4 week intervals the cast is removed, x-rays are taken, and a new cast is applied. It is discarded only when the fracture is healed. There is no need for physiotherapy to mobilize the wrist after the gauntlet is discarded.

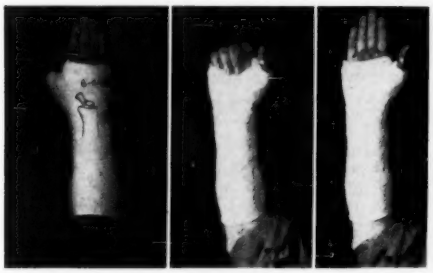


Fig. 5. Plaster-of-Paris gauntlet which affords adequate immobilization to the fractured scaphoid while permitting satisfactory use of the fingers and thumb.

There is a surprisingly rapid return of mobility and power without evidence of disability in these cases.

RESULTS

Of the 45 cases studied, only 28 remained under observation until their casts were discarded. There were no nonunions among these cases. Of the remaining 17 fractures, 12 were transferred to other camps while 5 were still in plaster casts. There was no indication by x-ray that any were developing nonunion. It is believed that adequate immobilization gives equally gratifying results in both types of cases. The average time required for healing of type I fractures was 8.3 weeks. The type II fractures required an average of 19 weeks for disappearance of the fracture line.

SUMMARY AND CONCLUSIONS

1. Fractures of the carpal scaphoid are caused by a fall on the outstretched hand in which the wrist is rigidly fixed by strong forearm muscles and hyperextension or hyperflexion is prevented. The impact causes the bone to crack at the waist and does not ordinarily cause displacement of the fragments.

2. Depending on the anatomical variations in blood supply to this bone, a fracture will not interfere with the blood supply to both fragments (type I) or will interrupt the blood supply to the proximal fragment (type II). There were 8 cases of type II fracture.

3. Interruption of blood supply to the proximal fragment leads to temporary avascularity but not necessarily to aseptic necrosis.

4. Temporary avascularity of the proximal fragment delays union but does not prevent it, provided the wrist is adequately immobilized.

5. There were no known cases of nonunion or of aseptic necrosis in this series. Credit is given to the absolute fixation afforded by the plaster-of-

Paris gauntlet which includes the base of the thumb.

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HERMAPHRODITISM

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IN order to clarify certain factors regarding hermaphroditism and its treatment, it seems fitting to begin the discussion with the history of a patient.

A woman, aged 23 years, consulted Dr. R. G. Worcester in April, 1941, seeking advice about the abnormal development of her external genital organs. These are the notes of the history she gave to Dr. Worcester:

When she was about 9 years of age, she realized that she was different from other girls and withdrew somewhat into herself. She did not confide in her mother, and her parents had never indicated that they thought she was in any way abnormal. She had never been medically examined before. During her childhood, she played with boys but states that this would have naturally occurred as no girls of her age were living close to her home. She played much sport at school, and was quite good at hockey and swimming. When she was about 13 or 14 years, her voice broke and has since become deep like that of a man. At about 14 years she developed hairs on the face and chest, and for the past 3 or 4 years has found it necessary to shave her face daily. She has never developed any breasts, nor has she ever menstruated. Her general stature has always been of the male type. She has been of an independent nature and went to work when she was about 17; the work being domestic service. She admires the male sex, and seeks her friends among it; several attachments have been quite serious. There has never been any attempt at intercourse but she states that this has been so because of her fear of "others finding out what she was like," and in any case she thought it would not be possible. Recently there had been a little soreness of and some whitish discharge from the vulval regions. Her main wishes were to continue living as a female and to have the abnormal swelling (very enlarged clitoris) removed.

On examination, the general body build was of the male type (Fig. 1). The features of the face were harder than in the average female, the development of the beard could not be judged, because she could not be persuaded not to shave even for a few days. There was an amount of hair on chest, abdomen, arms, and legs, greater than in many men. The voice was quite deep, but there was no Adam's apple formation of the larynx. The region of the breasts was completely flat. Heart and lungs were normal. The abdomen was soft. No tumor was felt on palpation. There was a very tender mass in the left groin. The external genitalia presented the following appearance: There was a considerably enlarged clitoris (Fig. 2), labia majora were present, labia minora hardly developed. The orifice of the urethra was at the basis of the clitoris. Posteriorly there was a "vagina," consisting of a narrow canal which allowed a catheter to be passed in for about 1 centimeter. Much yellow discharge was seen in this region. X-ray pelvimetry (by Dr. Colin Macdonald) showed an android type of inlet, but otherwise all the measurements were within the range of a female pelvis. An estimate of the 17-ketosteroids gave a value within the normal female limits.

From the Department of Pathology, Women's Hospital, Melbourne.

As the patient had most strongly expressed the wish that all possible male structures should be removed, an operation was performed on April 29, 1941. An incision was made over the swelling in the left groin; a gonad was found in the subcutaneous tissue superficial to the musculus obliquus externus. This was removed and the wound was closed. The abdomen was then entered through a midline incision and the other gonad was found near the internal ring at the right pelvic wall, and removed. This proved to be the only structure in the pelvis between bladder and rectum; there was no trace of a uterus or appendages. As a third step the enlarged clitoris was resected.

The removed gonads appeared macroscopically to be typical testes. On microscopic examination structures very much like those of undescended testes were seen (Fig. 3). The seminiferus tubules were well formed, they were usually lined by three or four layers of cells. These cells showed the usual differentiation, and a fair number of mitoses was present. Spermatogenesis, however, seemed to stop short of the formation of mature spermatides. The tubules were surrounded by very thick layers of connective tissue. The interstitial cells of Leydig were greatly increased in numbers, in one gonad there was a well defined nodule, measuring 4 millimeters in diameter, which consisted of rather immature interstitial cells.

The immediate postoperative course was uneventful However, to the surprise of all concerned, she developed within some weeks all the symptoms of an artificial menopause. Treatment was for a time somewhat irregular and not quite successful because Dr. Worcester had been called up for military service a few days after he had performed the operation. It was not until November, 1941, that carefully planned treatment was inaugurated. She received weekly injections of 40,000 units of estroform; after about 2 months the doses were gradually reduced to 10,000 units per week. This was continued until November 1942, i.e., injections were given for 12 months. Although a weekly injection of 10,000 units was just sufficient to keep her comfortable (one or two hot flushes used to occur on the last day of the week), a most remarkable transformation of the patient has occurred during the year. The hair growth on trunk and limbs has regressed to such an extent that it has become hardly noticeable. She reports also that the growth of the facial hair has regressed considerably, but self-consciousness still dictates daily shaving. The voice is now a somewhat broken alto. The patient has gained a good deal of weight, the deposition of fat tissue has occurred in a definite female pattern. Most remarkable, however, has been the development of her breasts. When first seen she had actually no more fat tissue in the region of the breasts than in the adjoining parts of the skin. About 3 months after the inauguration of the injections the areas just began to rise above the level of the surrounding skin. Twelve months later she has not very large, but very well developed breasts, as Figure 4 shows.

Of great interest are the psychological results of the treatment. She lost most of her self-consciousness. She took up swimming again, which she had not done for years, afraid of "being found out." It has been mentioned, that she had a "boy-friend" even before operation. During the year this relationship deepened considerably; according to her statements she enjoyed his attentions very much more

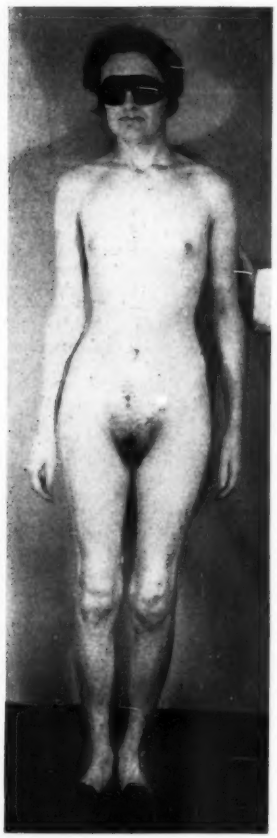

Fig. 1. Patient shortly after operation, before commencement of hormonal treatment. Note general male habitus, no development of breasts.

and she became very fond of him. They began seriously to think of marriage. The main obstacle seemed to be the impossibility of intercourse.

As shortly before a member of our hospital staff, Dr. K. Campbell, had reported success with Steinmetz's method of creating an artificial vagina, it was decided to make first an attempt at utilizing the existing rudimentary vagina. Dilators of varying size had to be made from glass, as other material was not available. Through the intelligent cooperation of the patient a vagina was obtained, which admitted two fingers to their entire length, in less than 6 months. Intercourse was then attempted and carried out to the satisfaction of both parties.

After 12 months' treatment by injections the medication was changed to stilbestrol by mouth, because the patient had taken up shift work which prevented regular attendances at the hospital. Although she now takes the tablets only when she is troubled with hot flushes, the general physical and psychological feminization continues, but, of course, at a much slower rate than in the initial stages. She became married 2 months ago and is enjoying married life fully, regretting only that she will not be able to have children. In 2 years her condition has changed to an extent which we had not expected when we rather diffidently commenced her treatment.

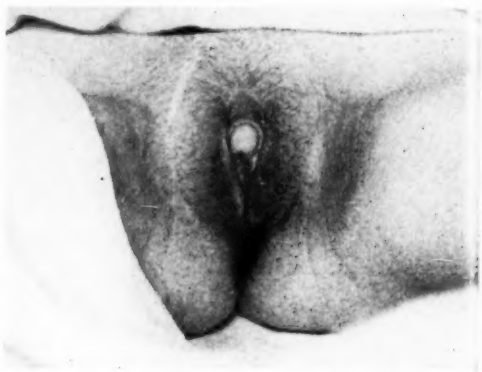

Fig. 2. External genitalia before operation.

As stated in the opening paragraph of this paper the history of the patient has been given in some detail, first, to give an account of the postoperative course and the social adjustment of the patient, considerations often omitted in discussions of similar conditions; and second, however, for the even more important reason that anyone who peruses this history must arrive at the same conclusion as in this case, that either our management of the patient has been completely misdirected, that we had no right whatever to transform an undoubtedly male person into a female, or that it is our conception of hermaphroditism which is totally wrong. There cannot be any doubt about the choice between these two alternatives. When one realizes that we helped a "sullen selfconscious freak" (her own words) to become a happy married woman; that we would have driven her to suicide had we told her to change her sex and start another life as a man, the only conclusion possible is that we have to revise our ideas about hermaphroditism.

When one tries to evaluate the literature one is very forcibly struck by the fact that the quantity and quality of papers dealing with this subject are inversely proportional to each other. This finds its explanation in a number of different factors. Many papers have been written at a time when essential details of anatomy, physiology, embryology, and genetics were not known, cases have been observed and reported on by busy practitioners who had either not the time or not the opportunity to study the details meanwhile discovered, but much of it is just due to careless-

ness. To give only one example: In 1938 MacCahey devised a new classification of hermaphroditism. For this purpose he selected from the easily available literature 67 cases as a basis for the four groups he proposed. In 1942 another author comes along, adds a few cases from the literature and two of his own, and "brings thus the numbers up to date." As a matter of fact v. Neugebauer had published in 1908 a monograph based on the analysis of 1,262 from more than 2,400 cases reported up to this time. In the face of this state of affairs no survey of the literature will be attempted. Suffice to say that still the most widely used classification is based on Klebs' scheme, which comprised three groups: (1) hermaphroditismus glandularis (true hermaphroditism), hermaphroditismus tubularis (pseudo-hermaphroditismus); (2) masculinus; and (3) femininus.

Numerous subgroups have been suggested to these main groups. Common, however, to all these classifications is the fact that, with the exception of true hermaphroditism (there are only about two dozen such occurrences), in all the others the anatomical structure of the gonads decides the sex of the cases. "Case" is purposely used, because none of these classifications has attempted to take into consideration the personality of those concerned. There is, however, no need, at least at this stage, to digress into this direction, it shall first be shown, that biological research over the past 20 or 30 years has led to results which are quite incompatible with the still widely prevailing ideas about hermaphroditism (hermaphroditism is used as a general term to include true as well as pseudo-hermaphroditism).

It is well known that a fertilized ovum has either a 1X (XY or XO) or a 2X (XX) constitution, and that accordingly a male or a female subject develops from it. It is, however, not so well known to the medical profession, that every cell carries male (*M*) as well as female (*F*) factors, the *F* factor in the sex chromosome, the *M* factor in another chromosome pair. The genetic formula for a male is therefore = *FMM*, for a female = *FFMM*. The usual clearcut sex determination results from a constant difference in the values of *F* and *M* in a given group; it can, however, be seen that the genetic sex differences are of quantitative rather than qualitative nature. Goldschmidt has shown that it is possible to obtain conditions, in which this difference (epistasis in his terminology) is not sufficiently large. To give an example: If one sets the value of *F* arbitrarily equal to 40, that of *M* to 30, the above formulae would read:

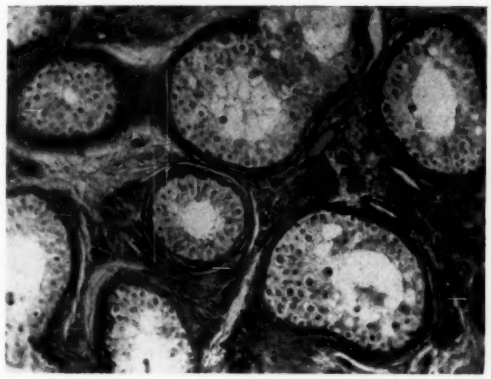

Fig. 3. Histological structure of the gonad: seminiferous tubules fairly well developed, but without spermatides, thick layers of connective tissue surrounding them. Abundance of interstitial cells.

$$FMM = 40 : 60 = ♂ \qquad FFMM = 80 : 60 = ♀$$

If in another group of the same species *F* were equal to 60, and *M* to 45, one would get the same proportional relationship:

$$F'M'M' = 60 : 90 = ♂ \qquad F'F'M'M' = 120 : 90 = ♀$$

By special crossbreeding one could arrive at an individual of the formula:

$$F'M\ M = 60 : 60 = \text{+}$$

or at another one

$$F\ F\ M\ M' = 80 : 75 = ⚥$$

In such cases the epistasis would be too small for a definite sex determination and some degree of intersexuality (Goldschmidt) would result. An individual with a genetic formula similar to the first is now called a male intersex, one with a formula similar to the second one a female intersex. The term hermaphroditism has been abandoned, except for those species in which the individual has both testes and ovaries functioning and can act as a male or a female as well.

That such deliberations are not idle speculation has been shown by Goldschmidt in very extensive experiments on the gypsy moth. He could by crossbreeding of two different races of this species obtain, at will, practically all intermediate stages between a normal male and a normal female animal. He could even show that complete sex reversal was possible, e.g., that genetically 2X individuals could become perfect males. (This can be proved, because "males by sex reversal" have, when mated to a normal female, only female offspring).

Fig. 4. Development of patient's breasts after 12 months' hormonal treatment.

In some detail Goldschmidt's conception is as follows: An intersex begins development according to its 1X or 2X constitution. Sooner or later, depending on the epistasis, a turning into the opposite direction of development occurs, i.e. a first phase of female development is followed by a second phase of male development or vice versa. What degree of intersexuality results depends on the situation of the "turning point," i.e., on the time, at which the second phase begins. A very early turning point may lead to complete sex reversal, a very late one can influence only organs and functions which have not yet become firmly established by this time. Goldschmidt's work has been confirmed by a number of investigators also for other animals.

The most important question now arises, whether these results can be applied to higher animals and to man, where for obvious reasons similar experiments are impracticable. There are two main difficulties which have to be overcome. First: in lower animals differentiation of the primary as well as the secondary sex characters is, as far as we know, solely dependent on the chromosomal mechanism. In higher animals and man, however, the sex hormones take over the directing and controlling functions at a comparatively early stage. Furthermore, in mammals and man the possibility of an influence of the maternal hormones on the fetus in utero will have to be taken into consideration. Secondly, while it seems quite possible that a human ovary may be transformed into a testis, it is much more unlikely, if not impossible, for a human testis to become an ovary. (The ovary has two generations of sex cords, the second develops into the specific structures, while the primary sex cords regress. Remnants of them, however, persist and could provide the material for the subsequent development of testicular structures. In a developing testis, however, there is supposedly only one generation of sex cords, thus material for a subsequent development of an ovary would not be available. See however later!).

About these two points a controversy has developed between Goldschmidt and other biologists. Goldschmidt has, in one of his publications, shown in great detail how his conception of intersexuality can be applied to all known examples of such occurrences, whether in lower or higher animals or in man. A short summary of his ideas about human "hermaphroditism" is all that can be attempted. The so called male pseudohermaphrodites are female intersexes, i.e., they have genetically a 2X constitution, but have undergone a varying degree of sex reversal. The so called true hermaphrodites are in principle nothing but the same. Only the transformation of ovaries into testes has not become complete. The so called female pseudohermaphrodites are, in his opinion, no intersexes at all, they are genetically normal females, they are cases of virilism due to hormonal disturbances during the fetal life, comparable to those which follow the development of certain ovarian or adrenal tumors in later life.

Space does not allow to follow Goldschmidt's reasoning in detail, only one point may be somewhat elaborated: his rather surprising refusal to regard the female pseudohermaphrodites as intersexes. His explanations are: Male pseudohermaphroditism, i.e., female intersexuality in man is much more common than its opposite, and one would expect about equal numbers, were both conditions based on a similar chromosomal mechanism. Female pseudohermaphroditism, i.e., male intersexuality, is practically unknown in higher animals and there is, in his belief, the impossibility of a testis becoming an ovary.

This application of the results obtained in lower animals has been objected to by Witschi, although he himself came to rather similar conclusions in experiments on toads. He agreed with Goldschmidt on the interpretation of the female pseudohermaphrodites. Also in his opinion they are cases of virilism in genetically normal females.

The male pseudohermaphrodites, however, originate according to him in genetic males. This opinion was mainly based on statistical evidence compiled by Pettersson and Bonnier, and Moebius: when one adds up the numbers of males, hermaphrodites, and females in the family of cases of hermaphroditism it looks indeed, as if one had to count the hermaphrodites with the males to arrive at about even numbers of male and females. Witschi suggested as explanation of male pseudohermaphroditism that some genetic disturbance in 1X—fetuses makes them susceptible to the influence of the normal or even abnormal estrogenic hormones of the mother.

To account for the various manifestations of pseudohermaphroditism Witschi had to assume that a first period of male development is followed by a second period of feminization, and that this is often followed by a third period of remasculinization. In those cases of male pseudohermaphroditism which later on develop breasts and other female features, this third period is supposed not to occur because the maternal influence has been so strong as to prevent a later endocrine function of such testes.

There seems to be several debatable points in this theory: masculinization, feminization, remasculinization, this appears to be even more complicated than Goldschmidt's suggestions. The explanation of the failure of the third period to occur is not quite satisfactory, because one had to assume that the testis had lost the power to produce androgens, but could still produce estrogens. It is further noteworthy, that the psychological development, especially feelings toward the one or the other sex, are often in contrast to the most conspicuous physical characters (as in our case: very marked male habitus, but definitely female behavior). In view of the facts that normal individuals of both sexes produce male as well as female sex hormones, only one in greater quantity than the other, and that testis and ovary are the common, but not the only source of them, it seems to me that even if hormones had such influences as Witschi suggests, the proportion of their production and their effect would depend more on genetic conditions than on anatomical structures. In a recent paper written in collaboration with Mengert, however, Witschi comes to the conclusion that the male pseudohermaphroditism should be divided into two groups: one, for which his first theory applies, and another one the members of which are genetically females, which have undergone partial sex reversal. He includes in this group especially those intersexes, which have in spite of the presence of testes fully developed secondary female sex characteristics. An important point in his deliberation is again the study of the family of the two cases on which his paper is based.

It is not possible for one who is not a trained biologist to decide whether the number of carefully analyzed families is great enough for such far-reaching conclusions, nor to pass judgment on the greater probability of either of these theories, but a most important conclusion can be drawn: Hermaphrodites are not, as we have been led to believe just males or females afflicted with a set of malformations; although they have a fundamental 1X or 2X constitution, there is a disturbance in the relationship of the *F* and *M* factors, either on a pure genetic basis (Goldschmidt) or a mixed genetic-hormonal one (Witschi). And that hermaphroditism is a deviation from the normal effects of the *F* and *M* factors, i.e., a state of intersexuality, is all that matters to the medical profession, not so much how it was brought about and whether it superimposed on an original 1X or 2X constitution.

One would have expected that these results of biological research would have made a profound impression on all subsequent medical writing. It is most astonishing that a study of the literature reveals that only very few serious attempts have been made to utilize these results from the medical point of view. Moszkowicz has tried in a number of papers to introduce Goldschmidt's work to the medical profession. He has in one of them pointed out that the position of even a rudimentary prostate is of great significance for the interpretation of doubtful cases. Finally, he published in 1936 a very comprehensive review (about 200 pages) of the whole problem, and in this he has actually gone a good deal further than Goldschmidt. He has incorporated a number of borderline conditions like hypospadia and even homosexuality; he regards female pseudohermaphroditism as male intersexuality for the reason that the embryological work of Gruenwald has shown that in contrast to the previous belief a developing testis has also secondary sex cords, which could provide material for a subsequent development of ovarian structures. He has actually drawn up a complete scheme for all possible stages of intersexuality. Even if one is doubtful whether this vast expansion of the original ideas were justified, as e.g., Goldschmidt does, one would at least expect that his papers would have become the basis for a fruitful discussion. Far from it. Also his work has had hardly any repercussions in the medical world. In 1937 H. H. Young published a book which is invaluable as a

documentary collection of cases of hermaphroditism; he even gives in an introductory chapter an account of Goldschmidt's work, but when he proceeds to the description and evaluation of his material he follows along the old familiar lines. Some later writers began to use in their publications "intersex" for pseudohermaphrodite, but, fundamentally, very little changed. Novak has attempted to introduce the new ideas into the American medical literature, although, as he himself says, in a somewhat sketchy way; again with very little success. Then there is Witschi and Mengert's paper, already referred to, in which Witschi comes closer to Goldschmidt's point of view, and in which he suggests that the nonenvironmental homosexuals might well be sex-reversed females, a suggestion which has already been made by Moszkowicz. McCahey's attempt of a new classification is of interest in so far as he abandons the use of the anatomical structure of the gonads as the main criterion of sex determination, but when he expresses the opinion that the cases with testes are male or female according to the presence of derivatives of the wolffian or muellerian ducts one cannot follow him any further. Although his suggestions were initiated by the feeling of dissatisfaction with the present state of affairs, they lead, I am afraid, not in the right direction, and it would be regrettable, if their acceptation would impede further progress which can be based only on the biological data.

The reasons why this paper has dealt to some length with the results of biological research are mainly these: first, a better acquaintance with these ideas will stimulate a more careful and better planned investigation of cases of hermaphroditism, the theory of Moszkowicz with regard to the significance of the prostate deserving special attention. Second, as soon as in the evaluation of cases of hermaphroditism the supremacy of the anatomical structure of the gonads is definitely broken, the way will be open for a better understanding and more reasonable management of such cases. One aspect of the *cases* but the most important one of the *patients* has often been unduly neglected, that is the psychological one. Patients, who come to seek medical advice, are not "cases with genetic or hormonal disturbances," they are human beings usually with quite a definite male or female behavior, who are worried by some physical aberrations, sometimes, however, in great distress over the discrepancy in their development and their up-bringing. Wise surgeons have already in the past refrained from telling their patients what was "the right thing to do," and have helped them to become as nearly as possible what they wished to be. But in doing so they have often been troubled by their conscience, by the feeling that they had really no right to do as they did. Often only half-hearted measures have been taken. It is hard to believe that one patient, described as a "brilliant female" was "relieved of her urge" toward her "own" (the male) sex by removal of the testes. Worst of all, plastic masculinizing operations have been done on children on the assumption that "anyway most of the pseudohermaphrodites are male." How distressing have been the consequences of such operations, when at puberty female breasts developed and female behavior became apparent!

In possession of the new knowledge the surgeon will have a different approach to such patients. He will realize that their management should follow these lines: In patients in whom ovaries are present, or when at least their presence is strongly suggested, it has first to be ascertained whether or not the symptoms of virilism are due to an ovarian or adrenal tumor. If such be found, its removal is usually followed by a remarkable improvement; menstruation and pregnancy may occur, although some features as facial hair and deep voice may be slow in disappearing. If no such tumor is found, the condition might be due to a hyperfunction of a not enlarged adrenal, or the patient might be a "male intersex" with a high degree of sex reversal. In the first case very little can be done, in the second management will have to follow similar principles as in the opposite condition to be discussed now. All cases in which testes are present, either alone or in combination with ovaries, should be regarded as intersexes. Whether they are based on male or a female genetic formula is a matter of great scientific interest but of very little practical importance. Sex reversal in such intersexes often affects the physical and psychological characteristics to quite a different degree, and for the plan of management it is only the psychological ones that count. If a careful psychological examination reveals a definite male or female behavior, the surgeon can, with a clear conscience, use his skill in correcting physical aberrations. If the psychological attitude is not so clear, a course which causes the least disturbance and promises the greatest improvement of the pre-existing conditions will have to be followed. But in any case, the anatomical structure of the gonads should be the least worrying factor. It has even become questionable whether in cases with definite female behavior the testes should be removed in every instance.

It has been shown that such operations often have the same effect as castration of healthy

women, hormone analyses have indicated that such testes often secrete estrogens and androgens in a proportion rather similar to that of normal females. The removal of such testes seems therefore unjustified in patients with fully developed female secondary sex characteristics; plastic surgery of the external genital organs may be all that is here required. Removal of the testes and subsequent administration of estrogens is indicated in cases with marked male physical secondary sex characteristics, but definite female psychological configuration. The governing idea should be to reaffirm the patient in its "psychological" sex and to do this with a minimum of surgical procedures. A plea for at least an attempt at using Steinmetz's method to obtain a satisfactory vagina, whenever a rudimentary one is present, may be added. One further point is self-evident. Plastic operations should be avoided in children. Moreover the final decision about their sex should be deferred until after puberty. This may be sometimes very difficult—children have to be brought up one way or the other—but with intelligent co-operation of patients or parents, a reasonable management often is possible.

SUMMARY

1. The history of a female intersex (male pseudohermaphrodite) is given in some detail in order (a) to show the postoperative course and the subsequent social adjustment of the patient and, (b) to indicate the incompatibility of the prevailing classifications of hermaphroditism with the clinical facts.

2. A brief account of the biological research work on hermaphroditism is given and the possibility of its application to the human condition discussed.

3. Suggestions for a suitable management of cases of hermaphroditism are made.

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ACUTE CHOLECYSTITIS

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FOR many years, and particularly for the past 5, medical literature has been replete with discussions, discourses, and statistical reviews representing actually thousands of patients operated upon for biliary tract disease. Lately the ever present argument occupies the front of the stage as to whether early, delayed, or late operation on the acute cholecystitis case gives the best mortality and morbidity results. Cholecystitis actually or apparently seems on the increase in the United States. At the gastrointestinal clinic in the Hospital of the University of Pennsylvania, Dr. T. G. Miller has found that biliary disease is responsible for 40 per cent of the complaints treated there. Perusal of the figures from dozens of clinics widely scattered over this country shows that approximately 20 per cent of all biliary cases must be classed as of the acute type of cholecystitis. We believe that the best results are obtained when surgery is undertaken in the early (hours) obstructive stages before infection *per se* has resulted in suppuration. An attempt will be made to present in compact form the accumulated statistics from the numerous published articles and from these results and our own experience to try to prove what factors are chiefly concerned in the mortality and morbidity of this disease.

For simplicity and in order to save printing, the bibliography of the reported statistics with few exceptions will be omitted, and the various references tabulated by serial numbers only.

AGE OF THE PATIENT

All writers on the subject are in accord in stating that the older the patient the higher the mortality and morbidity. It can be safely stated that 15 per cent of the people in the United States suffer from biliary disease, and that this figure increases to 30 per cent after 45 years of age. Crump states that at the postmortem table stones were found in 33 per cent and diseased gall bladders in 60 per cent of subjects. In fact a careful analysis of 1,960 reported cases shows that the mortality after 60 years is 8 to 10 times the mortality before that period. The reasons for this are evident. There is more serious biliary damage because of the long period of the disease existing before the acute attack precipitating operation; often pancreatitis and hepatitis together with cardiac and renal disease result in more frequent and even fatal postoperative complications. Then, too, the diagnosis is often more difficult to make because as is well known the aged patient does not show the same amount of rigidity, pulse, or temperature reactions as occur earlier in life. Furthermore the leucocytic reaction is less marked, and the indifference and lethargy minimize pain and tenderness in these elderly patients.

It is interesting to note, however, that in many series the mortality in the age period before 30 years is higher than it is in the period between 30 and 50 years. This is probably accounted for by the fact that the old adage fat and forty attracts our attention the most and so results in delayed diagnosis in the younger patients, with resultant catastrophes. The authors have operated upon several patients in the teens with acute disease, one, a 7 year old boy with gangrenous cholecystitis.

DURATION OF THE DISEASE

Graham aptly illustrates the danger of procrastination by citing operative mortality figures for cholecystectomy. If done after 2 attacks it is 2 to 3 per cent, after 3 or more attacks 8 to 9 per cent, in the presence of jaundice 10 to 12 per cent, and with pancreatitis it is 50 per cent. Miller at the Massachusetts General Hospital noted that in the fatal cases the average period from the onset of symptoms to operation was 15 days, while in those who recovered it was but 8.3 days. Zinninger noted that with delayed operation one-third of the patients recovered, one-third did not change, and one-third became definitely worse. The above data should favor early (hours) operation. Comparison of Tables I and II shows that the 48 hour group has the lower mortality. The 20 series contain only cases of acute cholecystitis.

SEX

At the Union Memorial Hospital in Baltimore the mortality in men was 15 per cent and in women it was 6 per cent. In our series the only 2 deaths were in males operated upon with a suspicion of acute appendicitis. Other clinics show

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TABLE I.—REPORTED STATISTICS MORTALITIES — CHOLECYSTECTOMIES PREDOMINATING (4-1) ALL CASES REGARDLESS OF DURATION

Series	No. cases	Mortality per cent
1	159	8.3
2	44	4.5
3	129	16.3
4	320*	5.3
5	197	5.
6	150	6.2
7	300	10.
8	107	9.3
9	153	5.8
10	140	8.6

*No cholecystectomies in this series.

These figures were obtained from the reports of 10 clinics appearing in the literature within the last 5 years. They represent the run of the mill with regard to the duration of the attack which to some extent may account for wide difference in mortality figures. These are all acute cases.

TABLE II.—REPORTED STATISTICS MORTALITIES — CHOLECYSTECTOMIES PREDOMINATING (12-1)*—DURATION LIMITED TO 48 HOURS

Series	No. cases	Mortality per cent
11	20	5.
12	50	4.
13	7	0.
14	19	5.2
15	6	0.
16	51	3.9
17	12	0.

*Note the effect of early operation on the ratio 12 cholecystectomies to 1 cholecystostomy.

These figures also were obtained as were those in Table I but represent only those patients operated upon within the first 48 hours of the illness. Compare the difference in the number of cases in the two tables.

similar results. Two reasons present themselves to us to account for this difference—first, the fair, fat, flabby, fertile, flatulent female of forty (the seven f's, aptly expressed by Owen of Philadelphia) with a pain in the upper abdomen immediately suggests gall-bladder disease as the most likely diagnosis, whereas in the average male, a peptic ulcer or coronary disease are first impressions, thus resulting in delays incident to the establishing of a definite diagnosis. The second reason is that most often in the female the distended viscus points toward the umbilicus whereas in the male it very often points out toward the flank. The complaint, therefore, is frequently erroneously diagnosed as an acute appendicitis, an enlarged tender kidney, or a lesion in the hepatic flexure.

DURATION OF THE ACUTE ATTACK

The time that elapses between the onset of symptoms and surgical intervention has a definite bearing on the mortality. Hedy shows in 3,986 cases that the safest time for operation is between 6 and 24 hours. Lanahan in 140 cases, however, has the highest mortality in the 24 hour or emergency group. Several other men report a relatively high figure in this group. A possible explanation of this occurrence may be that the emergency operations are often done by the younger, less experienced surgeons, at night, with hurried preparation, the least experienced anesthetist, and an interne (maybe, in these days, a very green one) as assistant, and a pupil nurse as suture helper, likewise green and frightened. We all have seen such setups more than once in many hospitals.

American surgeons who have ardently supported early operation are Alexander, Estes, Eliason, Finney, Graham (H. T.), Heuer, Judd and Phillips, Lund, Mentzer, Miller, Owings, Pratt, Royster, Stone, and Zinninger. Others equally well known and experienced recommend delayed operation—such men are Bass, Behrend, Bruggeman, Branch, Deaver, Flint, Graham (E. A.), Lewis, and Lahey.

When such an array of authorities disagree there must be something in their statistics that does not meet the eye. Do they all use the term "early" meaning hours only or do they mean 2 or 3 days? Have the early mortalities been in their hands or in the hands of young assistants? In the early fatalities have the patients been opened with a mistaken diagnosis of appendicitis or a salpingitis and a second incision or supplementary anesthesia been necessitated? It would seem in all fairness that such data should be available to justify fatalities that should not occur. For, it is a strange thing that although surgeons are almost universally agreed that acute appendicitis should be treated surgically as an emergency (hours, not days), yet in the case of acute cholecystitis, in which it is generally agreed that one cannot prognosticate the severity of the pathological condition, they wait an indefinite time before undertaking surgery. This position seems doubly untenable when some writers report perforations as having occurred in 24 hours. McNealy reported 3 such cases. It would appear that these time periods must have been estimated from the time of admission to the hospital and not from the onset of the disease—another example of the uncertainty of statistical interpretation. It is true that the average time elapsing before perforation is about 6 or 7 days, with an average mortality for all reported perforations approximating 45 per cent. In 35,000 cases mentioned by Heuer, 20 per cent went to perforation with a mortality of 10 per cent. Why wait for such catastrophes? The variation between 45 per cent and 10 per cent is possibly accounted for by the time lag before

TABLE III. — CHOLECYSTOSTOMIES PREDOMINATING (9-4) ALL CASES REGARDLESS OF DURATION

Series	No. cases	Mortality per cent
18	44	2.2
19*	135	1.5

*(personal series)
These are the only two series reported in which cholecystostomy predominated.

operation and the type operation, whether a cholecystectomy or a cholecystostomy was performed. Eliason and MacLaughlin reported 9 perforations with 1 death. This death followed a cholecystectomy, the 8 survivors had cholecystostomies performed—a significant factor as the surgeons with the high mortalities had practiced cholecystectomy uniformly (Table II).

CULTURES

Negative cultures from the gall bladder were noted in approximately 50 per cent of collected data and would seem to indicate that obstruction and possible chemical reaction are the important factors in the early stages (24–48 hours) of so called acute cholecystitis. This is borne out by our pathologist who states that but for the clinical picture of acute infection he could not truthfully describe a great proportion of these specimens as being the seat of an acute infection, but would rather favor that of a vascular obstruction diagnosis. Evidences of true acute inflammation histologically are difficult to find in a fibrosed, thickened gall-bladder wall. The commonest organism was the colon bacillus (25 per cent of infected cases). The combined data from Finsterer, Smith, and Kruger with 517 cases mention only 1 patient as dying from peritonitis. The data presented therefore should lead one to discount the importance of the infectional factor, as a contraindication to early operation as has been held by several authors.

Confusion has arisen due to the failure of many advocates of early surgery to state clearly in their account:

1. Whether immediate operation means an emergency procedure done within 1 hour or 2 of the onset of the illness, or after the patient's admission to the hospital, or one done after complete studies can be made to assess the patient's condition and time allowed for the required preoperative preparations to be carried out, regardless of the duration of the acute attack.

2. Whether cholecystectomy is done as a routine procedure or the operation is adapted to the findings.

TABLE IV.—REPORTED STATISTICS — FUNCTION AFTER CHOLECYSTOSTOMY

		Per cent
Moore	Normal	60
Jenkinson	Normal	68
Mock	Normal	70

3. Whether the incidence of the late complications of biliary fistula and strictures of the ducts following the removal of acutely inflamed edematous gall bladders has increased therefrom.

PRELIMINARY TREATMENT

In cases with a positive or proved diagnosis seen during the first few hours of an attack, morphia hypodermically and atropine should be given at once and everything withheld by mouth. Fluid, preferably glucose 5 per cent in salt solution, and water is given by venoclysis. Operation is undertaken as soon as the necessary general medical survey can be carried out, bearing in mind the frequent coexistence of diabetes and cardiac disease with biliary tract disease. At this stage the absence of edema, as a rule, permits the ideal cholecystectomy to be performed. Those patients, however, who have been ill 24 to 36 hours without adequate treatment are also best managed by this same regimen of morphine, venoclysis, and starvation for 12 to 18 hours. If after this period any one symptom fails to subside, operation is done. Similarly patients admitted after 24 or more hours who are still ill despite this proper treatment, should have prompt operation. It has been our experience that acute obstructive gallbladder disease of 2 or more days' duration as a rule will not subside completely under any treatment except surgery, hence further delay is dangerous and useless. The procedure may be either cholecystostomy or cholecystectomy, depending upon the local conditions which do not permit safe surgery, such as the absence of induration or edema around the ducts, obscured anatomy, pancreatitis, jaundice, perforation, etc.

The pathological state of the gall bladder cannot be safely estimated by any physical or laboratory tests—hence the danger of delay. Not infrequently the problem will arise of persuading a patient to have the operation when he or she seems to have recovered. Such patients are courting certain trouble and the necessity for operation should be insisted upon at the first evidence of suggestive symptoms. Here the persuasive aid of the attending physician is invaluable.

Before the actual surgical treatment is determined it might be well to pause for a moment and discuss the subject in its broadest sense. We must

remember that our first aim is to save life and our next aim is to restore health. When we read the statistics in the literature and see their enormous variation, we must appreciate the fact that the mortality and morbidity figures will be much higher among average surgeons than those published by the surgeons with a much greater experience. Perhaps it would be better should a higher percentage of cholecystostomies be performed and a more frequent use of drainage in both cholecystostomies and cholecystectomies be instituted. In the ultimate analysis the patient who can't reach a large city clinic is interested in what chance he or she has with their local surgeon. For all to attempt cholecystectomies that may result in disaster is not justified (Tables III and IV).

PERSONAL EXPERIENCE

In determining the operation to be done, the crux of this problem lies in the recognition not only of the fact that acute cholecystitis demands early surgical intervention but that the operation must be suited to the existing conditions. Accordingly the procedure which may be ideal from the standpoint of ultimate morbidity may have to be modified for the sake of immediate mortality. Cholecystectomy is a better operation than cholecystostomy but the latter may frequently be safer and more prudent. The rule must be observed absolutely that cholecystectomy should never be done unless the relationships of the hepatic, cystic, and common duct, and the cystic artery can be clearly visualized by the surgeon. Granting that in all cases cholecystectomy is more satisfactory from the standpoint of ultimate results, the indications for cholecystostomy may be stated as follows: (1) when the condition of the local tissues militates against safe removal of the gall bladder; (2) when the physical difficulties of obesity, uneven anesthesia, poor illumination, or inadequate assistance make proper exposure impossible; (3) when serious local complications such as jaundice, pancreatitis, or cancer call for drainage only; (4) when age or serious renal, cardiovascular, or pulmonary complications indicate that surgical intervention should be simple and expeditious. The safety of the patient is greatly enhanced if the surgeon will recognize not only his own limitations but also those of his patient, and stop with a cholecystostomy rather than attempt too much at one operation. Time and our patience will not permit the hundreds of statistics which prove that cholecystostomy has a higher mortality than does cholecystectomy. We must bear in mind that a simple drainage of an acute cholecystitis would not have any higher mortality, if as high as that of cholecystectomy, except for the serious complications, already present, which would result just as fatally and be charged to a cholecystectomy, if such were done.

OPERATIVE TECHNIQUE

Cholecystostomy. Infiltration anesthesia with procaine may be used in bad risk patients on whom the simplest form of operation is to be done. Whenever circumstances permit, spinal or inhalation anesthesia is preferable since it gives more adequate exposure and enables the surgeon to do a more satisfactory operation.

As to the incision, our preference is for the subcostal approach, the line of skin incision being one finger breadth below the costal margin and parallel with it. In the unruptured case when cholecystectomy is deemed advisable, the field is cofferdammed and a gauze pack is also placed on top of the liver edge beneath the costal arch. This incision exposes a minimum of small gut and hence minimizes the danger of spread of infection. The gall bladder is opened with the sharp Ferguson drainage suction tip and so emptied. It is now opened wider and emptied of stones and inspected with the scope. The senior author and L. K. Ferguson have devised a cholecystoscope which is on the order of a short sigmoidoscope and carries a light at the tip and suction channel. This is a great aid in visualizing the inaccessible portions of the gall bladder. This has enabled us to recover stones in 15 per cent of cases in which our fingers and scoops have missed them. When all stones have been removed, clear bile may enter the gall bladder although often the edema about the cystic duct prevents its immediate appearance. Cholecystostomy, although a stop gap procedure in many instances, has resulted in cures in approximately 84 per cent of the cases upon whom we have employed it. The use of the cholecystoscope may be a factor in our results immediately as well as in reduction of future recurrences since stones are rarely left behind by this method.

In addition to tube drainage into a bottle, a Penrose cigarette drain is placed down along the bladder in every case. The figures in our series would seem to justify this procedure. Decompression drainage was carried out with little success and bile restored to the stomach by tube or lyophylization if necessary. It is our impression, although not checked, that the wounds in these cases compare favorably with the cholecystectomies as far as herniation occurrence.

Cholecystectomy. From the technical standpoint considerable muscular relaxation is essen-

tial for proper exposure. Nitrous oxide and oxygen alone will not provide this with safety even with an expert anesthetist. Cyclopropane or ethylene may do so. Ether by open drop or in combination with gaseous agents is the most dependable and satisfactory of the inhalation methods. Due to the characteristic short necked, wide chested configuration of many patients with gall-bladder disease, the endotracheal technique of administration of inhalation agents is often of great aid in insuring an unobstructed airway and controlling the depth of anesthesia. Local infiltration with novocain has been espoused by some enthusiasts but requires considerable skill and much patience. Spinal anesthesia in our hands is being used more and more since the advent of the physician anesthetist. When combined with heavy preoperative medication or intravenous pentothal it is very satisfactory.

The same incision is used for cholecystectomy as for cholecystostomy. There is more than one way of removing a gall bladder but we prefer first to identify the cystic duct and its relation to the hepatic and common ducts, ligate it and the cystic artery, and then proceed with the dissection of the gall bladder from its bed, beginning at the ampulla. This enables the operator to visualize these structures in a dry field and permits the accomplishment of the difficult and precarious portion of the operation with the best visibility. Deaver has pointed out that the textbook description of the relations of the biliary ducts obtains in only 58 per cent of the cases. In 26 per cent the hepatic and cystic duct run parallel to one another and the former may be injured if care is not exercised. Accessory ducts are present in 8.7 per cent, the most common anomaly being an accessory right hepatic duct arising from the cystic. Ligation of this may be fatal and leaving it wounded and open will result in a biliary fistula. It is helpful to remember that the veins in the plexus over the cystic duct lie parallel with it whereas over the common duct they form a network. If exposure is inadequate at this point it is sometimes helpful to aid in the rotation of the liver by placing a gauze pack over its dome. By means of a ligature carrier or a curved hemostat, two strands of No. 1 chromic catgut are passed around the duct, and the latter is doubly ligated close to its juncture with the common hepatic duct. In the presence of much edema the tying of the vessels should be done slowly and snugly and a final inspection should be made to be sure that the artery is still closed. Ofttimes bleeding is seen through the ligature as it presses the edema out of the ligated tissue. Routinely a soft cigarette drain is placed in the fossa above the duodenum and brought out on the lateral angle of the wound. We have never had cause to regret this procedure. Not infrequently bile stained drainage material for several days makes the surgeon thankful that the wound was not tightly closed. Partial cholecystectomy has not been necessary with us as yet. A cholecystostomy has been deemed preferable. Occasionally a stone has been left in an inaccessible position in a patient desperately ill for later removal if necessary.

RESUMÉ OF CASES

In our series of 135 consecutive cases of acute cholecystitis classed as such by the pathologist, the procedures here outlined were practiced uniformly with the following results:

Mortality. There were but 2 deaths—1.5 per cent mortality in the series. Interesting facts about the deaths: both were men, one was operated upon under spinal anesthesia 2 hours after admission, under the mistaken diagnosis of acute appendicitis. Through a second incision, a cholecystostomy was performed. The patient died on the 4th postoperative day with acute congestive heart failure and bronchopneumonia. The other death was of a 54 year old man, sick 2 weeks, operated under spinal anesthesia 48 hours after admission, and a cholecystostomy was performed. He was a diabetic with rheumatic and arteriosclerotic heart disease with auricular fibrillation. He died on the 9th postoperative day from a mesenteric thrombosis.

Age group. In the first group between 10 and 30 years, there were 23 cases; in the second group between 30 and 50 years, there were 48 cases; in the third group between 50 and 80 years there were 37 cases and 1 case was over 80 years of age.

Clinical course. In 21 per cent of the series the leucocyte count was normal; in 23 per cent temperatures were normal; in 30 per cent there was no palpable mass; in 28 per cent there was no suggestive previous history; and in 4 per cent no local tenderness was elicited.

Hospitalization delay. In 20 per cent operation was carried out within 24 hours; in 76 per cent operation was carried out within 48 hours; in 90 per cent operation was carried out within 1 week.

Pathological condition. Of the 135 cases of acute cholecystitis there were with perforation 17 with no deaths; with empyema 38 with 1 death; and with gangrene 46 with 1 death.

Perforation was found in 17 cases with a localized pericystic abscess. In this group 6 patients had the acute attack less than 1 week before operation and in 4 gall badder perforated in less than

5 days after onset. All but 4 of the patients were operated upon within 48 hours of their hospitalization; 1 patient was treated conservatively for 2 weeks when signs of perforation developed. There were no deaths in this series. All had cholecystostomies performed with drainage of the associated abscess. Empyema was present in 38, or 28 per cent of the series. Gangrene was reported in 46 or 34 per cent—the greater majority of these were gross impressions of the surgeon and were not confirmed by the microscopic sections. Jaundice was present in 13 per cent of the series.

Operative procedure. Cholecystostomy was done in 92 or 68 per cent of the cases with a mortality of 2.1 per cent. The common duct was explored in 3 of these. Cholecystectomy was performed in 43 cases or 32 per cent with no deaths. The common duct was explored in 8 of these. Jaundice was present in 13 per cent of the series.

Indications for cholecystostomy in this series may be summarized as follows: (1) poor general condition, 24 cases; (2) local abscess, 16 cases; (3) anatomy obscuration, 45 cases; (4) pancreatitis, 11 cases; (5) jaundice, common duct not exposed, 9 cases; (6) inability to catheterize the common duct sphincter, 2 cases; (7) technical reasons—obesity, 2 cases; (8) no reason given, 7 cases.

Results. There was a mortality of 1.5 per cent. The morbidity report is as follows:

Ninety per cent of the series was followed from 3 months to 8 years. All of the cholecystectomies were reported well at last follow up.

Five patients returned in 6 months for elective cholecystectomy—in none of these had there been a return of symptoms. There was no death following these secondary operations.

Fifteen patients, or 16 per cent, with previous cholecystostomy returned with recurrence of symptoms or a persistent fistula (mucous).

One patient required a cholecystogastrostomy for pancreatic obstruction.

One patient had a second cholecystostomy in an acute attack.

All the others, 13 in number, had cholecystectomies. In other words 21 per cent of the cholecystostomies had second operations with no mortality. There were no deaths in this group following the secondary operative procedure.

Eighty per cent of these recurrences were in evidence in less than a year after the original cholecystostomy.

It would appear therefore that most individuals relieved for a year have a very good chance of permanent relief. It is with this in mind we advise against further surgery until a return of symptoms but when this does occur they must seek immediate surgery.

SUMMARY

A series of 135 cases of acute cholecystitis in which operation was done is reported, with a mortality of 1.5 per cent.

Early operation (hours) after proper preparation was practiced.

Cholecystostomy was employed in 68 per cent of the cases and cholecystectomy in 32 per cent. Subcostal incisions were used throughout. All wounds were drained. The 2 deaths were in cases of cholecystostomy in extremely poor risk patients.

All the cholecystectomy cases were cured.

Eighty-four per cent of the cholecystostomy cases were without symptoms at last follow-up.

There were no deaths in any of the secondary operations in the cases with a primary cholecystostomy.

CONCLUSIONS

Early surgery in the acute attack as well as in the course of the disease, made possible by the co-operation of the physician, will reduce mortality and morbidity. Judicious choice of the procedure to be employed is necessary. The surgeon should recognize his own as well as his patient's limitations; it might be better in certain difficult cases to leave an impacted stone behind the duodenum or even in the cystic duct until drainage through a cholecystostomy relieves inflammation, induration, and jaundice.

Postoperative care is extremely important. It should be directed toward the prevention of hypoventilation and pulmonary complications by posture, deep breathing exercises and change of position; the prevention of abdominal distention by suction drainage of the stomach; the prevention of concealed hemorrhage and biliary peritonitis by the use of a drain; the maintenance of liver function by the use of decompression drainage and the sustaining of metabolic and fluid balance by the administration of blood or glucose and salt intravenously.

Only by strict attention to all these principles can we hope to reduce the mortality and morbidity of biliary disease.

EDITORIALS

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THE TREATMENT OF INTERTROCHANTERIC FRACTURES

FRACTURES of the hip, which are common accidents in the aged, cause much pain and disability and frequently lead to hypostatic pneumonia and death. With the development of various hip nails and pins and the improvements in their use, the worst of these complications have been materially reduced. Nevertheless, the great amount of attention which has been directed to the operative treatment of hip fractures in recent years has been concerned mainly with those in the neck of the femur. The equally common fractures at the base of the neck or in the region of the trochanters have received less attention because they were believed to be less serious and less likely to be followed by nonunion and deformity. This conventional view has been disproved by recent more careful studies of the problem.

Trochanteric fractures occur in older patients than fractures of the femoral neck and since they are caused by more severe injuries, they are followed by a higher death rate. In several statistical studies which have been reported in later years, it has been found that trochanteric fractures occur almost as often as fractures of the femoral neck and that they affect men more often than women. Also, the right hip is the one principally involved.

A complete classification of trochanteric fractures is difficult since they are so varied in type and location. They may take the form of a simple crack across the base of the femoral neck, a comminuted fracture from the greater trochanter to the lesser trochanter ("intertrochanteric"), a fracture across the shaft between the trochanters ("pertrochanteric"), or in the region of the shaft below the lesser trochanter ("subtrochanteric"). It is easy to see, therefore, how diverse the therapeutic problems may be, depending upon the type and location of the fracture.

The treatment of trochanteric fractures is mainly directed toward the alleviation of pain and prevention of deformity since nonunion does not occur as it so often does in fractures of the femoral neck. The blood supply to the trochanteric region is entirely adequate to overcome the damage resulting from a fracture, whereas in the femoral neck the blood supply is precarious and fractures in this location are often followed by nonunion or aseptic necrosis of the head of the femur.

The original plan of treatment of all hip fractures involved simple immobilization in external splints. The first to recommend this method was Ambroise Paré and his successors include Hodgen of St. Louis, John Ridlon, Nicholas Senn, D. P. D. Wilkie, and finally Royal Whitman. For simple fractures at the

base of the neck without displacement, these appliances were fairly successful. However, the confining effects of such splints too often produced pressure ulcers, muscular weakness, and residual joint stiffness which interfered with complete recovery. Moreover, later observations have shown that such so called "conservative treatment" is attended by a high mortality which neutralizes any advantages of the closed methods of treatment.

The utilization of traction to immobilize trochanteric fractures is subject to many of the same criticisms. Gibson's well-leg traction, Gordon Buck's adhesive traction, the Maxwell-Ruth combined traction, Russel's balanced traction, Roger Anderson's and Carl Jones' well-leg traction likewise confine the patients to such an extent that pressure ulcers are likely to form and stiffness of joints frequently results. These complications delay recovery and the final condition of the patients is too often unsatisfactory.

Internal fixation of trochanteric fractures has reached a stage of development where it promises the most satisfactory effects of any of the established forms of treatment. Screws, nails, and pins which were suitable for fractures of the femoral neck have been utilized in trochanteric fractures but they were found to be suitable only in those cases which were not comminuted or in which the lateral cortex of the trochanter was intact. To increase their usefulness, plates have been attached which anchor the nails to the femoral shaft below the site of the fracture. More recently, one piece angle nails have been evolved by Jewett, Neufeld, and Moore which are universally applicable to all types of trochanteric fractures whether simple, comminuted, or spiral.

With modern anesthetics of less shocking action and intravenous fluids which are free of untoward reactions, operations upon very old patients can be undertaken with much more confidence than in former years. Moreover, since it has been found that "conservative treatment" is attended with high mortality, it is preferable to consider internal fixation of trochanteric fractures unless the patients are so frail and feeble that there is no hope of survival. Also, with internal fixation, pain is reduced to the lowest level so that depressing narcotics are seldom necessary and patients can be assured of more nearly normal hip function afterward. The arguments against internal fixation are that elderly patients are poor operative risks and that they are already suffering from the shock of a severe accident. Nevertheless, this can be countered by the fact that patients whose fractures are immobilized with internal fixation suffer less pain, they are more likely to survive, and they are left with less disability at the end of treatment.

WALTER G. STUCK.

POSTMORTEM EXAMINATIONS OF MILITARY PERSONNEL

WE, as physicians, are particularly concerned in these days with the welfare of the individuals in the military forces of this country. We feel fairly certain that no measure is being overlooked which will help to prevent the occurrence of disease or will hasten its relief if it once strikes. Wounds are being treated more promptly and with better success than ever before, and the death rate from the afflictions of war, considering all the hazards which surround modern warfare, is astonishingly low.

However, some must and will die and our concern about these does not end with their death. It is a debt to those still living, as well as to generations still unborn, that the circumstances surrounding their death and the conditions which are revealed in examinations after death should be recorded in as carefully detailed a manner as is possible under the cir-

cumstances. The information as to why they died is always pertinent and may be exceedingly valuable. Unexpectedly vulnerable portions of the body might be better protected, when death follows use of unusual or new instruments of destruction, provided proper analysis is made of such wounds. Usual or new infections may be guarded against if we know they are rampant. In fact the assay of the effectiveness of all preventive and remedial measures against death from disease or wounds is furnished by a properly performed and recorded postmortem examination. The terribly grim phases of war are further evidenced by the fact that such examinations of the bodies of our enemies, who are found by our forces or who, while prisoners, die in spite of our treatment and hospital care, may reveal the relative efficiency of our offensive weapons as well as the general health of our opponents.

Perhaps more important than the revelation of the immediate causes of death is the further inquiry into what manner of men, physically speaking, our dead really were. What were the ravages of childhood diseases, improper nourishment, tuberculosis, or other chronic acquired, as well as inherited, diseases? With how great a deficiency in physical resources do our young men start out on an active adult life? What is the reason for this deficiency and how can it be improved or prevented? In short, how can our future fathers and mothers, with the help of the family physician, raise a healthier and sounder generation? These questions and many other considerations which might be raised, are sufficient justification for urging the necessity of thorough study of the bodies of those who die in the military services.

During the first World War pathologists accumulated many valuable records of examinations made after the death of soldiers who had died from disease or wounds. In the following years attempts were made to supplement these records by postmortem studies made at veterans' hospitals and other places. Unfortunately, divided responsibilities made impossible any systematic collection of such records which, if they could have been centralized and annotated, would have furnished an additional commentary on the postwar or remote effects of injuries and illness acquired in active service. It is still not too late following the first World War, and certainly not too early in this second World War, to plan a coordinated survey of postmortem examinations, whether made after death in the course of active service or after death which occurs when the service man has returned to civil life. The fact that deaths among navy, coast guard, marine, or army personnel are subject to more or less separate and specialized regulations and customs, particularly regarding medical postmortem examinations, does not tend to promote uniformity in methods or results. Coordination of records of such examinations apparently is not at present possible but for the future welfare of our nation some effort toward this end would appear to be highly desirable.

There is no implication in the above that this phase of the medical services to our armed forces has been, or is being, neglected. However, for obvious reasons its fundamental values and the organization and correlation of its activities has not received much open discussion. It is for this reason that expression has been given to a defense of procedures which perhaps need no defense and a brief exposition of how, in this final sacrifice, the dead may not have died in vain. H. E. ROBERTSON.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

NOT a textbook, but a monograph, Dr. Goodall's *A Study of Endometriosis, Endocervicosis, and Peritoneo-ovarian Sclerosis*[1] is therefore to be considered apart from the usual run of textbooks which are designed for students or general physicians. It presupposes a considerable gynecological experience and familiarity with both pathology and physiology.

We are glad to welcome a careful review of an important gynecological disease, and wish there were more such works. The practice of writing and publishing such monographs is not as common in this country as it is in France, where theses on various subjects are part of the required training for certain medical degrees. The reviewer has found these theses an invaluable source of knowledge in looking up particular gynecological subjects. For this reason, we welcome Dr. Goodall's study.

Dr. Goodall's monograph, however, differs from these foreign theses in that his is a presentation of his personal views and not an exposition of the known information on endometriosis. For that, it cannot be criticized, even though one may not agree with all of the author's views. We think it would have added greatly to its value and permanence, as a record, if it had presented a broader view of the subject.

Since it is a dissertation primarily on the pathology and etiology of endometriosis, the clinical features are more or less secondary. In the brief clinical sections, however, the author concentrates his wide practical experience. These sections would be of great value to all physicians, especially those who see many female patients.

We regret the absence of a bibliography. That is almost a basic requirement for a monograph, and we wonder why it was not included.

When viewed as a monograph of the author's personal views, this work can be appreciated as a contribution of great worth, based on a wide clinical and scientific experience. LAWRENCE WHARTON.

THE volume of 128 small pages, *War Injuries of the Chest*[2] by Davies and Coope, is strongly recommended as a practical guide in the management of traumatic thoracic injuries. Although the subject could not be completely covered in detail in such a small volume, a surprising amount of useful, specifically detailed instruction is given. Emphasis has been placed upon the fundamental importance of correction of derangements in thoracic physiology. In the words of the authors, "The physiological conditions of the chest and of the heart and lungs so intimately determine the very existence of the patient that the right application of the principles which follow from them is vital, not only for ultimate recovery but even more so for the immediate saving of life."

The two principal authors and the seven collaborators have presumably based their teaching upon first-hand experience with war casualties in England. Mr. Davies is well known in America as a pioneer in modern thoracic surgery and is the author of a number of books on thoracic surgery. Doctor Coope is the physician to two important Liverpool chest hospitals. The collaborators in the preparation of this book include four thoracic surgeons, two anesthetists, and a pathologist.

In such a relatively young and developing specialty as thoracic surgery, differences of opinion between even experienced surgeons are inevitable. This reviewer happens to differ with the authors' preference for intercostal catheter drainage for pleural fluid collections instead of a partial rib resection for the airtight introduction of a tube that is sufficiently large not to become occluded by débris. He is also opposed to the partial replacement by air of pus aspirated from a total empyema, since the air rises to the top of the pleural cavity and prevents the rapid expansion of the upper lung. The same objection applies to the partial replacement by air of blood aspirated from a hemothorax, should the hemothorax be infected, or later become infected. The substitution of air for blood is, of course, necessary if the hydrostatic pressure of the blood is causing cardiocirculatory or respiratory decompensation and if present or recent bleeding from a wound of the lung requires continuing pulmonary collapse. The English authors' fear of ether anesthesia in the presence of pulmonary infection and their opinion that "cyclopropane is the best anesthetic for all operations involving the thorax" are not shared by the anesthetists in the principal thoracic surgery clinics in this country.

The personal disagreement about a very few things expressed in the last paragraph is trivial when weighed against the overwhelming rightness of the teachings of this book, which should be thoroughly studied by every surgeon who cares for war injuries, or civilian traumatic injuries, of the chest.

JOHN ALEXANDER.

[1] A STUDY OF ENDOMETRIOSIS, ENDOSALPINGIOSIS, ENDOCERVICOSIS, AND PERITONEO-OVARIAN SCLEROSIS; A CLINICAL AND PATHOLOGIC STUDY. By James Robert Goodall, O.B.E., B.A., M.D., C.M., D.Sc., F.I.C.S. (Hon.), F.R.C.O.G. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1943.

[2] WAR INJURIES OF THE CHEST. By H. Morriston Davies, M. Ch., F.R.C.S. and Robert Coope, M.D., F.R.C.P. Edinburgh: E. and S. Livingstone, 1942.

THE book entitled *Pictorial Handbook of Fracture Treatment*[1] has served its purpose very well and fulfills the title of the handbook.

The discussion is kept simple without any unnecessary theorizing, and only well grounded accepted principles are presented with excellent illustration. The drawings by Dr. Harold Laufman bring out all the desired details which might be confusing from the written matter in the discussion. Both the nonoperative and operative treatment of the fractures of the body are discussed, and with very few exceptions the textbook follows good orthodox teaching.

It will be of considerable value to both medical students and the general practitioner, who has had no special training in this particular field.

CARLO S. SCUDERI.

A TIMELY addition to the literature of nursing *Nurses in Action*[2] may be characterized as a, seven volume library dealing with the various though related aspects of army life. The introduction from the pen of Lieutenant Colonel L. L. Gardner, M.C., A.U.S., says of Colonel Flikke: "She speaks with the conviction and intimacy of a lifetime of Army service, and her words are freighted with all the special knowledge and authority which derive directly from her distinguished position as Superintendent of the Army Nurse Corps on duty in the office of the Surgeon General of the War Department, Washington."

The book opens with a lively description of the nursing scene as it is enacted today in the many parts of the world where Army nurses are found. The picture has two distinct appeals: a vividness which cannot but stir the enthusiasm of the new recruit and a wealth of anecdotes, garbed though they are in modern dress, which will bring both tears and smiles to the veterans of World War I.

"The History of the Army Nurse Corps," which follows, traces in interesting fashion the development of the Corps from its earliest days up to the present.

The following chapters, "Becoming an Army Nurse," "Nurses at Work" and "Nurses in Action," describe the life of an army nurse, its joys and its sorrows, its duties and its privileges, offering authoritative answers to many of the questions which beset the director of nursing today. Throughout, the ideals of service, teamwork, and loyalty to a great tradition are paramount.

The concluding chapter "Other Government Services" enhances the usefulness of the book and will be welcomed by teachers of nursing history and professional adjustments. *Nurses in Action* should prove a valuable addition to the nursing school library.

ELIZABETH W. ODELL.

[1] PICTORIAL HANDBOOK OF FRACTURE TREATMENT. By Edward L. Compere, M.D., F.A.C.S., and Sam W. Banks, M.D. Chicago: The Year Book Publishers, Inc., 1943.

[2] NURSES IN ACTION; THE STORY OF THE ARMY NURSE CORPS. By Julia O. Flikke, Colonel, A.U.S., with an introduction by Lt. Col. L. L. Gardner, M.C., A.U.S. Philadelphia: J. B. Lippincott Company, 1943.

THE small, 187 page text, *Aids to Surgical Anatomy*[1] will quite certainly be found of use to students during their senior year and when they are preparing for their final examinations. The sections on the head and neck are covered amazingly well in this second edition to which new material has been added. The surgical significance of anatomy is also adequately considered for a text so small. If there were more than the twenty-six illustrations, the book would have a greater teaching value. This abbreviated "Surgical Anatomy" with its wealth of information well merits study by surgical residents beginning their careers.

SAMUEL J. FOGELSON.

THE revised and enlarged edition of Cole and Puestow's *First Aid*[2] fulfills a real need for authoritative information about first aid in civilian as well as in military practice. The new chapters on miscellaneous conditions requiring first aid and the sections on medical emergencies, poisons, and foot lesions are particularly valuable just at this time.

The authors present the latest information regarding the treatment of wounds, burns, and shock, and present the problems of abdominal pain and abdominal injuries in an instructive manner. All of the illustrations are well chosen and carefully designed to supplement the text. The authors emphasize the importance of having thoroughly trained first aid personnel if the greatest good is to be accomplished.

In addition to the two authors, seventeen members of the teaching staff of the University of Illinois College of Medicine have contributed chapters to this volume. All medical students should be encouraged to master the fundamental principles of medical and surgical practice as they are set forth by these teachers.

This volume is highly recommended to civilian and military doctors, nurses, and medical students and to those laymen who are charged with the responsibility of first aid instruction and care in industrial and civilian defense work.

LOUIS G. HERRMANN.

THERE can be no question about the value of Dr. Geist's monograph on *Ovarian Tumors*.[3] It is very well illustrated. His opinions, gleaned from his vast experience, are of great help in the understanding of ovarian tumors. The chapters on embryology, anatomy, and physiology are important and the presentation is clear and concise. The book is full of foreign references but there is a definite dearth of references to English and American writers.

There is nothing of importance left out of this book. It could be wished that speculation as to the estrin, female sex hormones, and ketosteroids in male tumors and estrin and female sex hormones in female tumors had been included. Dr. Geist's ex-

[1] AIDS TO SURGICAL ANATOMY. By J. S. Baxter, M.B., M.Sc., F.R.C.S.I. 2d ed. Baltimore: The Williams & Wilkins Co., 1942.

[2] FIRST AID; SURGICAL AND MEDICAL. By Warren H. Cole, M.D., F.A.C.S., and Lieutenant Colonel Charles B. Puestow, M.C., A.U.S. 2d ed. New York and London: D. Appleton-Century Co., Inc., 1943.

[3] OVARIAN TUMORS. By Samuel H. Geist, M.D. New York and London: Paul B. Hoeber, Inc., 1942.

perience with the comas alone might well open the way to research into the various hormonal titrations in such conditions.

The great diversity of ovarian tumors and cysts will always prove a beautiful hunting ground for the gynecologist and especially for those interested in pathology and endocrinology. This book goes a long way to being the perfect reference book and should be near the clinician's desk and the pathologist's bench.

JOE VINCENT MEIGS.

THE concise monograph by Eli Moschcowitz[1] on the subject of vascular sclerosis, reviews the important clinical, investigative, and pathological work that has been done on arteriosclerosis. It is written considerably from the standpoint of the pathologist but also from that of the clinician. For one interested in the problem, it comprises an excellent review of the whole general field.

The so-called degenerative diseases are becoming the most important group in our progressively aging population. Arteriosclerosis in its various forms is the most important single member in this group. Because of this fact, it behooves the profession as a whole to become more and more acquainted with and interested in this disease process. A great mass of investigative and pathological data has been assembled to date and this has been covered ably in a very brief and concise monograph, which undertaking has not been satisfactorily done previously, though several lengthy volumes have been written on the subject.

In spite of the great amount of literature available, arteriosclerosis still remains essentially a mystery, at least in so far as etiology is concerned, and probably as well as regards practicable therapy. From these viewpoints, the problem remains to be elucidated.

The author summarizes in 18 short chapters of a total 171 pages the following more important headings: arteriosclerosis, hypertension and arteriosclerosis, pathogenesis of arteriosclerosis, etiology of hypertension, mechanism of hypertension, Monckeberg's sclerosis, phlebosclerosis, sclerosis of the chambers of the heart, experimental arteriosclerosis, the relation of diabetes and arteriosclerosis, and diagnosis and prognosis of arteriosclerosis. He also reviews briefly the medical and surgical management of arteriosclerosis.

There are occasional interpretations of certain of the pathological features involved which may well be disputed by many of those having special interest and insight in the problem. Some of the terminology utilized is, of course, also different from that which others chose to use.

For those having interest in this disease and all its ramifications, this monograph is well worth reading, as it presents a brief summary of the knowledge to date regarding the problem. For detailed and complete information on the special or allied subdivisions of the disease, one must consult the more lengthy individual monographs in great numbers.

ARTHUR F. BRATRUD.

[1] VASCULAR SCLEROSIS; WITH SPECIAL REFERENCE TO ARTERIOSCLEROSIS; PATHOLOGY, PATHOGENESIS, ETIOLOGY, DIAGNOSIS, PROGNOSIS, TREATMENT. By Eli Moschcowitz, A.B., M.D. London, New York and Toronto: Oxford University Press, 1942.

WITHIN a volume of about 150 pages Dr. Colsen[1] has covered the field of fractures quite completely. It is written in compendium style rather than outline. Every sentence is concise and clear in its brief explanation of the fundamentals and theories of fractures and fracture treatment. The 157 line drawings amply illustrate the text.

The author rightfully states that it was written for the undergraduate, as it is adequate as a reference work. A medical student having had only moderately good teaching in fractures could absorb this little book and pass any ordinary examination given on the subject. It should, therefore, be helpful to the undergraduate teacher.

J. E. M. THOMSON.

THE work by Paul Titus entitled *Atlas of Obstetric Technic*[2] is well conceived as to content and arrangement, and will doubtless fill a need in the postgraduate training of physicians in obstetrics and gynecology. The illustrations are excellent and well chosen to convey the idea the author has in mind. These, together with the comments are effective for the most part, in not only expounding the technique, but also in safeguarding the patient from misapplication of the various procedures.

However, as the book is designed "to be of interest and of some degree of value to general practitioners and obstetrical specialists alike," from the viewpoint of the general practitioner, one cannot but question the advisability of some of the illustrations. For example, there are a number of illustrations which illustrate myomectomy during pregnancy and several high forceps operations, giving undue emphasis without sufficient precautionary advice.

Episiotomy closure of skin with deep retention sutures of silk or linen "to be removed on the sixth day" does not seem to us to be the best method of closure. Similarly, closure of third degree lacerations by the use of silk, linen, or fine stainless steel wire for the rectal mucosa—knots being buried in muscle bed—does not seem good technique. Further, we would question the method for classical cesarean section, by abdominal incision two-thirds below and one-third above the umbilicus, a recommendation sure to be productive of postoperative ventral hernias if generally followed. And finally, the use of continuous catgut sutures while not commonly depicted could certainly be reduced to give a better concept of up to date surgery.

These criticisms are not serious ones when the book is perused and evaluated as a whole. It will form a valuable adjunct to all who have occasion to teach the technique of obstetrical procedures.

HERBERT F. TRAUT.

[1] FRACTURES AND FRACTURE TREATMENT IN PRACTICE. By Kurt Colsen, M.D. Johannesburg: Witwatersrand University Press, 1942.

[2] ATLAS OF OBSTETRIC TECHNIC. By Paul Titus, M.D. St. Louis: The C. V. Mosby Co., 1943.

IN answer to a long felt need *A Handbook of Medical Library Practice*[1] has been compiled and published. As is stated in the preface, its purpose is to serve as a "manual of procedure and a reservoir of useful data," and as a supplement to general guides to library practice and the usual library school background. Each chapter is written by a member of the compiling committee of the Medical Library Association. Chapters cover history and administration, book selection and ordering, cataloging, subject headings, classification, selection and handling of ephemeral material, pictures, microfilms, etc., rare books and the history of medicine, and reference work. Appendices contain lists of medical libraries, expansion of medical classification schemes, and annotated bibliographies of reference books for the study of rare books and medical history (458 items) and other reference books (603 items).

This is the first attempt at a comprehensive guide for medical libraries and, as such, worthy of high praise and a place on the shelves of every medical and scholarly library. However, it should not be used uncritically. The material on library collections in the United States is admittedly incomplete and, in some instances, definitely misleading. The balance of some sections is affected by the omission of important material believed to be covered in other manuals. Both inclusions and omissions in the reference sections are open to question. All of these criticisms were anticipated by the compilers.

After several years of trial, the book should be revised.

LOUISE WALKER.

THE book, *Pain Mechanisms*[2] by W. K. Livingston, is a thought-provoking work. Here is a concept of pain and an interpretation of its possible mechanisms. The first section of the book deals with the anatomy and physiology of pain conduction. The middle portion is devoted to a consideration of clinical case histories and the final chapters to interpretations.

The author persistently searches for the "how" and the "why." Because of the complexity of the subject, not all questions can be answered satisfactorily, but each discussion is cautious, conservative, intelligent, and very worth while. One is impressed with the author's persistent search for the true cause of the pain in each case because he is of the opinion that there must be a reason for the pain if it can only be discovered. Of no less importance is the necessity for early control or eradication of the pain, if possible, because "pain frequently exceeds its protective function and becomes destructive." Of particular interest is his theory of the mechanism of the so-called "vicious circle."

This book should be read by every student and practitioner of medicine and surgery.

GEORGE H. COLEMAN.

IN the past several direct studies of the human stomach were conducted and reported in detail. The first by Beaumont was definitely pioneer work and for that era and the facilities available during that period must be considered one of the foremost physiologic experiments of all times. Some 75 years later Carlson conducted a similar experiment which added materially to our knowledge of gastric physiology. During the interlude between these two elaborate experiments other similar studies of lesser scope were made. However, there still remained many muted topics disclosed by meticulous clinical study enhanced by direct study of the stomach by the gastroscope. It could be reasoned that some salient features either had been overlooked or not brought into the previous studies; therefore, the report by Wolf and Wolff[1] is not only interesting but advantageous.

The subject studied was a male who for 47 years had been fed through a gastrostomy opening because of a complete obstruction of the esophagus. This report is unusually interesting because the subject was apparently in a state of excellent nutrition and well suited to the types of observations and experiments employed since he manifested many of the psychic reactions so prevalent at this time such as anxiety, fear, depression, and pride. Basic studies of motor and secretory activity and vascularity were made. These were found to vary greatly under various conditions. The effects of heat and cold, smoking, and sundry drugs such as atropine, antiacids, epinephrine, vasodilators, and constrictors were noted. Also the effects of the direct application of mechanical trauma, alcohol, mustard, and many other substances that are commonly eaten or given in the course of medication were studied. The reactions in many instances were contrary to generally conceived ideas. Probably the most interesting phase of the study was observing the reactions associated with varying emotions such as the edematous engorgement of the mucosa of the stomach with resentment and mucosal erosion associated with hyperemia, hyperacidity, hypermotility, and adherent coagulated mucus associated with sustained resentment. The observations further seemed to verify the previous conclusion that mucus is the great protective agent for the gastric mucosa.

No dogmatic conclusions are drawn; however, the authors suggest a thesis that warrants serious consideration. It is rather well summarized in a paragraph in the final chapter. "Consulting a physician and placing reliance on him gives the patient the conviction that he is being 'backed up' and his feeling of being caught, of being alone, or of frustration are mitigated. Furthermore, his reliance on the

[1] A HANDBOOK OF MEDICAL LIBRARY PRACTICE; INCLUDING ANNOTATED BIBLIOGRAPHICAL GUIDES TO THE LITERATURE AND HISTORY OF THE MEDICAL AND ALLIED SCIENCES. Based on a preliminary manuscript by M. Irene Jones. Compiled by a Committee of the Medical Library Association. Edited by Janet Doe. Chicago: American Library Association, 1943.

[2] PAIN MECHANISMS; A PHYSIOLOGICAL INTERPRETATION OF CAUSALGIA AND ITS RELATED STATES. By W. K. Livingston, Lt. Com. M.C., U.S.N.R. New York: The Macmillan Co., 1943.

[1] HUMAN GASTRIC FUNCTION; AN EXPERIMENTAL STUDY OF A MAN AND HIS STOMACH. By Stewart Wolf, M.D., Captain, M.C., A.U.S., and Harold G. Wolff, M.D. London, New York, Toronto: Oxford University Press, 1943.

physician lessens the additional threat which merely being ill offers the patient's security. At the first sign of improvement from a regime of alkalis and cream, his horizon appears brighter. The hyperaemia and the engorgement of his mucosa related to his reaction are reduced. Pain and tissue damage occur less readily. The chain has been broken. If one can prevent new links from being forged, the patient continues to improve."

The impression obtained, however, is that the observations noted have a far greater significance than appears on the surface. This little monograph bears reading and re-reading. It will stimulate other studies that may reveal some of the mysteries of adverse responses of the human body to causes hitherto unsuspected. JOHN A. WOLFER.

THE 300 page book *Manual of Fractures*[1] by Shaar and Kreuz is concerned with the treatment of fractures by external skeletal fixation embodying the use of the Stader splint. It is based on an experience with over 157 cases of various types of fractures and orthopedic problems occurring in healthy young adults cared for in a Naval hospital. It stresses the point that fundamental principles of accurate reduction, rigid uninterrupted fixation and early restoration of function are accepted as axiomatic in the treatment of fractures. The manual is intended for those surgeons in military service, particularly Naval, (the Army frowns upon the use of the Stader splint) who must care for numerous casualties in a short space of time, often under difficulties.

Essentially the Stader splint is lauded as fulfilling all requirements for rigid fixation and for transportation, even for long distances over land or sea, of patients suffering fracture. No claim is made that the method of external fixation, acknowledged as an old one, is a short cut to fracture treatment and healing and it is stressed that the training of the surgeon in mechanical and physiologic methods and knowledge is required.

Nine sections of the book divide it into 27 chapters of irregular size, some extremely brief. In sequence the sections discuss: (1) general consideration of external skeletal fixation including the principles of Stader reduction and fixation splint; (2) the Stader splint including mechanical principles and methods of application; (3) delayed union and nonunion including the relation of external skeletal fixation to these problems; (4) descriptive chapters on fractures of the mandible, clavicle, humerus, radius and ulna, femur, pelvis, tibia and fibula and os calcis; (5) complications in fractures, compound fractures, with osteomyelitis, old ununited fractures and nonunion; (6) arthrodesis of joints, knee and hip; (7) bone grafts; (8) incidence of fractures in the service; (9) anesthesia and x-ray study used in external fixation. Section IX, comprising 59 pages, is written by Lt. Commander D. E. Hale and the roentgenologic study by Lt. Commander S. L. Casper. For good measure an appendix on the treatment by skeletal traction, of fractures at sea, is added.

The technical methods of application are well described and although warning is given that external skeletal fixation is not for every fracture, a clear list of contraindications for its use is not given. The chapter on fractures of the mandible is perhaps the best. The cause and mechanism of pin seepage and the description of the Stader splint are well done and illustrated. One learns that several different sizes of splints are required, depending on the bone to be splinted, and that a rather cumbersome two-man hand drill is needed for boring holes in the bone. No mention is made of the possible cost of these outfits for civilian hospital use.

Like any other manual this one cannot completely cover the treatment of all fractures. It is a specific and illuminating report on external fixation methods. The format is good, the illustrations numerous, but not always thoroughly informative, and there are a shockingly large number of split infinitives in the text. One feels that the text may have been rather hurriedly assembled and that the extremely terse sentences and widely used outline style represent skeletal notes as well as skeletal fixation. The experiences and methods given will be profitable to those treating fractures, understanding as expressed by the authors that these old and revived methods are not cure-alls. KELLOGG SPEED.

THE 684 page book *Rehabilitation of the War Injured*[1] edited by Doherty and Runes is in the nature of a symposium on a collection of carefully chosen articles on the rehabilitation of certain selected types of war, and in a few instances, of industrial injured. The contributors are chiefly British medical officers who have had wide experience in the fields of reconstructive surgery, neurology and neurosurgery, psychology, blindness and deafness, amputations, tuberculosis, medicolegal problems connected with pensions and compensation, and the rehabilitation methods pertinent to the disabled in these various fields.

Rehabilitation is referred to as a new department in the practice of medicine, yet reconstructive surgery and rehabilitation were born in the throes of World War I. We note the same ideals and the same definitions for the rehabilitation of the present war injured as were expressed in the previous war, viz., the physical and mental reclamation of the disabled as far as was humanly possible and their restoration as useful members of society rather than as pensioners and dependents robbed of incentive and initiative.

The chapters on the rehabilitation of the victims of head injuries are especially valuable. Not even one intensely interested in the care of brain injuries can read these contributions without being aware of

[1] MANUAL OF FRACTURES; TREATMENT BY EXTERNAL SKELETAL FIXATION. By C. M. Shaar, M.D., F.A.C.S., and Frank P. Kreuz, Jr., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1943.

[1] REHABILITATION OF THE WAR INJURED; A SYMPOSIUM. Edited by William Brown Doherty, M.D., and Dagobert D. Runes, Ph.D. New York: Philosophical Library, 1943.

his own shortcomings in handling acute head injuries in such a way as to avoid the psychoneurotic aftermaths which are so frequent and often so permanently disabling. In fact, the book is so filled with common sense lessons in the art of rehabilitative medicine that no physician, regardless of his specialty, should miss reading it.

We recommend it especially to the medical officers in our Army and Navy. The chapters on plastic surgery, the care of burns, the remedial treatment of scars and amputations, as well as those dealing with special defects such as blindness and tuberculosis are packed with concise, useful information. It stirs your imagination and carries your viewpoint beyond the immediate care of the wounded. It makes you a definite link in the rehabilitation of every disabled soldier that passes through your hands.

HARRY E. MOCK.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE 1943 YEAR BOOK OF RADIOLOGY. DIAGNOSIS edited by Charles A. Waters, M.D., and Whitmer B. Firor, M.D. THERAPEUTICS edited by Ira I. Kaplan, B.Sc., M.D. Chicago: The Year Book Publishers, Inc., 1943.

EXPERIMENTAL SURGERY; A LABORATORY GUIDE FOR UNDERGRADUATE STUDENTS. By J. M. McCaughan, B.S., M.D., Ph.D. St. Louis: The C. V. Mosby Co., 1943.

MANUAL OF SURGERY. By Rose & Carless. American (16th) ed. Edited by William T. Coughlin, B.S., M.D., F.A.C.S. From 16th English ed. by Cecil P. G. Wakeley, D.Sc., F.R.C.S., F.R.S.E., F.R.S.A., F.A.C.S., F.R.A.C.S., and John B. Hunter, M.C. M. Chir. Cantab., F.R.C.S. Eng. Baltimore: The Williams & Wilkins Co., 1943.

NOTES FOR THE R.M.O. OF AN INFANTRY UNIT. By C. P. Blacker, M.C., M.A., M.D., F.R.C.P. Oxford War Manuals. Edited by Rt. Hon. Lord Horder, G.C.V.O. London: Humphrey Milford (Oxford University Press) 1943.

WHITE BLOOD CELL DIFFERENTIAL TABLES. By Theodore R. Waugh, B.A., M.D., C.M. New York and London: D. Appleton-Century Co., Inc., 1943.

HOLT'S CARE AND FEEDING OF CHILDREN. Revised and enlarged by L. Emmett Holt, Jr., M.D. New York and London: D. Appleton-Century Co., Inc., 1943.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M. Ch. (Edin.), F.R.C.S. (Eng.). With a Foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.). 5th ed. Baltimore: The Williams & Wilkins Co., 1943.

THE FOOT. By Norman C. Lake, M.D., M.S., D.Sc. (Lond.), F.R.C.S. (Eng.). 3d ed. Baltimore: The William & Wilkins Co., 1943.

TRAUMATOLOGIA DE GUERRA. By Dr. Terencio Gioia. Buenos Aires: Aniceto Lopez, 1943.

LIBRO DE ORO; DEDICADO AL PROFESSOR DR. ALBERTO BARALDI, 1915–1940. Rosario, Rep. Argentina: Emilio Fenner, 1942.

PAIN; PROCEEDINGS OF THE ASSOCIATION, DECEMBER 18 AND 19, 1942, NEW YORK. Research Publications of the Association for Research in Nervous and Mental Disease, Vol. 23. Edited by Harold G. Wolff, M.D., Herbert S. Gasser, M.D., and Joseph C. Hinsey, Ph.D. Baltimore: The Williams & Wilkins Co., 1943.

SURGICAL ERRORS AND SAFEGUARDS. By Max Thorek, M.D., LL.D., D.C.M., F.I.C.S. With a Foreword by Sir Hugh Devine, M.S., Hon. F.R.C.S. (Eng.), F.R.A.C.S., F.A.C.S. (Hon.), and a chapter on Legal Responsibility in Surgical Practice by Hubert Winston Smith, A.B., M.B.A., LL.B., M.D. 4th ed. Philadelphia, Montreal, and London: J. B. Lippincott Co., 1943.

THE HOSPITAL IN MODERN SOCIETY. Edited by Arthur C. Bachmeyer, M.D., and Gerhard Hartman, Ph.D. New York: The Commonwealth Fund, 1943.

BACKACHE AND SCIATIC NEURITIS; BACK INJURIES—DEFORMITIES—DISEASES—DISABILITIES. With Notes on The Pelvis, Neck, and Brachial Neuritis. By Philip Lewin, M.D., F.A.C.S. Philadelphia: Lea & Febiger, 1943.

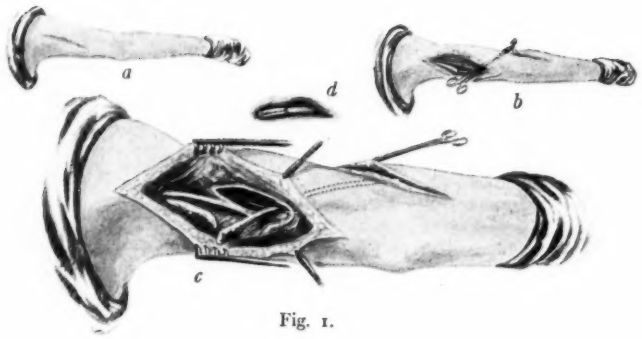

Fig. 1.

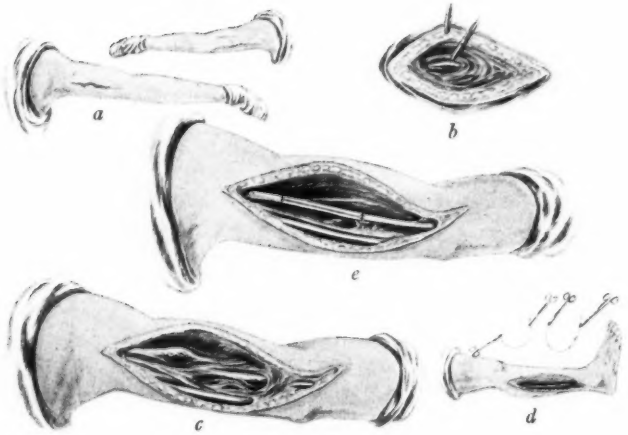

Fig. 2.

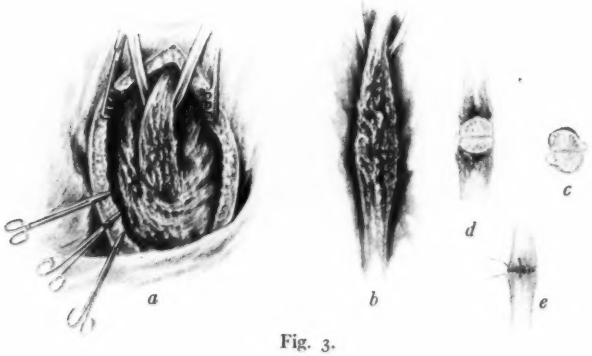

Fig. 3.

Surgical Treatment of Peripheral Nerve Injuries.—
Claude C. Coleman